EVALUATION OF ELECTRICAL SUPPLY ALTERNATIVES

FOR SEYMOUR ARM, B.C.

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FOREWORD

The Seymour Arm Electrification Study has been written in two stages to suit the requirements of the sponsors and to allow time for comments between the stages. The Stage 1, Technical and Cost Evaluation, was primarily designed to refine earlier cost estimates and ensure that all were technically viable. The study also presented a scenario for dividing the system costs among the eventual users of the power with the idea of stimulating discussion amongst the concerned parties leading to an equitable division of costs.

Subsequent to the completion of the Stage 1 Study in December 1983, the community of Seymour Arm proceeded to follow the recommendations of the Stage 1 study by:

- meeting with concerned organizations;
- devising a workable financing scheme;
- refining the capital cost estimates;
- scheduling a referendum to allow property owners to vote on the proposals.

The Stage 2 study evaluated the economic and financial costs of the alternative power supply schemes in terms of present values, recognizing that there was a national and a local perspective to the final costs. The study was conclusive in that the grid connection alternative was the least costly in all cases. Changing various parameters to check for sensitivity did not change the overall attractiveness of the scheme. The Stage 2 study also attempts to provide a realistic scenario of consumer costs based on the latest available information. It should be noted that some of the information differs slightly from the Stage 1 report and it will continue to be modified as costs and contributions to the project are finalized.

SUMMARY

Stage 1

The community of Seymour Arm lies at the northern end of Shuswap Lake in British Columbia. It consists of a mixture of summer cabins, permanent residences, farms and commercial establishments, all of which rely on independent power generation systems. Permanent residents pay an average of over $1000 per year for an electricity supply that falls short of provincial normals. Over 200,000 litres of diesel fuel and over 65,000 litres of propane are used annually to provide the service that is provided by hydro generated electricity in most areas of the province.

The community is making an effort to secure an adequate and economical power supply which reduces the amount of oil used, an objective which is consistent with that of the Remote Community Demonstration Program. The purpose of this Stage 1 study is to determine the most attractive power supply option, either a grid connection, a hydro power system, or a diesel generation system. The alternative systems are examined in terms of their capital costs and long term operating costs.

This report concludes that the most attractive system is the grid connection, based on its flexibility to expand, its lower present value cost and its ease of maintenance. The grid connection provides good opportunities for the community to participate in some aspects of the construction, and thus reduce overall costs.

The grid connection is attractive from the viewpoint of overall system costs, but it is still relatively expensive, because the small community must absorb much of the installation cost, despite a generous allocation from BC Hydro through a Rural Electrification Assistance grant. One of the major difficulties in developing a power supply scheme is to equitably divide the community's share of capital cost amongst the property owners. A cost sharing scheme is proposed in this report but further interaction with the community will be required to assure an acceptable formula. Subsequently, in Stage 2 of the study, an economic and financial evaluation was made, which analysed the costs of the power supply options from the national and local perspectives and which provided insight into the mechanisms available to enable a community power supply system to be implemented.

SUMMARY

Stage 2

The community of Seymour Arm, which has co-sponsored this Stage 2 Economic and Financial Evaluation of electrical supply alternatives, has continued to work towards establishing a community power supply while this study was in preparation. Based on the results of the Stage 1 study, which favoured a grid connection, meetings have been held with all concerned parties to establish an implementation plan.

This Stage 2 study examines the economic and financial aspects of all the options considered (grid connection, hydro power plant, diesel generating station) and tests each for sensitivity by varying parameters. The economic analysis examines the power supply options in terms of economic resources only, and as such the national viewpoint is expressed. Land, labour, equipment, material, diesel fuel and hydro electricity are all evaluated in terms of their social opportunity costs or their most valuable use in another application. The grid connection alternative is judged by a wide margin to be the least cost option from the national perspective.

The financial analysis re-examines the costs of the three alternatives from the viewpoint of the property owner at Seymour Arm. Full account of all taxes, grants, subsidies and actual at-site costs is taken into consideration as well as the effect of inflation. The main differences in the accounting method for the financial analyses when compared with the economic analyses are in the ways diesel oil prices and electricity prices are treated together with the effect of subsidies. The financial evaluation also leads to a clear recommendation of the grid connection as the least costly choice for the residents of Seymour Arm.

The choice facing the property owners of Seymour Arm is whether they are prepared to pay the residual cost of the grid connection based on a tax increase which is proportional to property assessments. This method is considered the fairest as it is simple to administrate and makes a reasonable assumption that a property owner's house and improvements will benefit more from the grid connection if the house is more valuable to begin with. Owners of vacant lots also receive a benefit as property values are enhanced and the possibility of a future, convenient power connection readily exists.

If the residents choose in favour of the grid connection in a referendum to be held in May 1984, much work still remains as the details of the project will require considerable organization and management to carry it through to a successful completion. *

* The Columbia Shuswap Regional District held a referendum in summer 1984, asking Seymour Arm residents if they were willing to pay increased taxes to cover the cost of a transmission line from the provincial power grid. The community voted against the motion.

EVALUATION DES MODES D'APPROVISIONNEMENT EN ELECTRICITE APPLICABLES A SEYMOUR ARM (C.-B.)

RESUME

Phase I de l'etude

Située à l'extrémité nord du lac Shuswap, en Colombie-Britannique, l'agglomération de Seymour Arm est un amalgame de chalets d'été, de résidences permanentes, de fermes et de commerces qui ont leurs propres groupes électrogènes. L'habitant de cette localité paie en moyenne au delà de 1 000 $ par année un service d'électricité qui ne satisfait même pas à la norme provinciale. Pour obtenir un service énergétique équivalent à la plupart des autres régions de la province, les habitants de Seymour Arm utilisent plus de 200 000 litres de diesel et de 65 000 litres de propane chaque année.

La collectivité se cherche un mode économique de production d'électricité, en quantités suffisantes pour réduire sa consommation de mazout, objectif bien conforme à l'optique du Programme de démonstration dans les collectivités éloignées. Comme premier pas, elle s'efforce dans la présente étude de déterminer l'option la plus viable, de la connexion au réseau provincial, de la mini-centrale hydro-électrique ou d'un groupe électrogène au diesel, en termes d'immobilisations et de frais d'exploitation à long terme.

En conclusion, le rapport établit que le meilleur choix est la connexion au réseau, étant donné ses possibilités d'expansion, son faible coût en valeur actualisé et sa facilité d'entretien. Par ailleurs, cette option offre l'avantage que la collectivité peut elle-même participer aux travaux de construction, ce qui en réduit le coût global.

Bien que ce coût global soit avantageux, cette solution demeure relativement chère car la petite localité doit absorber la plus grande part des frais d'installation, en dépit des généreuses subventions offertes par la B.C. Hydro pour l'aide à l'électrification en milieu rural. Il est difficile surtout de partager équitablement les frais collectifs d'immobilisation entre les différents propriétaires. Un mode de partage est préconisé dans le rapport, mais la collectivité devra être davantage consultée avant d'en arriver à faire l'évaluation économique et financière qui déterminera les moyens dont dispose le village pour se doter d'un réseau d'électricité.

.../2

Phase II de l'étude

La population de Seymour Arm ne s'est pas croisé les bras à attendre les résultats de l'étude qu'elle co-parraine et qui vient d'entamer la deuxième phase, soit l'évaluation économique et financière des diverses options d'approvisionnement en électricité. En effet, après avoir pris connaissance de l'option recommandée à la fin de la première phase, c'est-à-dire la connexion au réseau provincial, les habitants se sont réunis avec tous les intéressés pour en arrêter le plan d'exécution.

En deuxième étape, entre temps, l'étude fait l'analyse économique et financière de toutes les options envisagées (connexion, centrale hydro-électrique, groupe électrogène au diesel), qu'elle évalue en fonction de divers paramètres variables. L'analyse économique examine les options uniquement en fonction des ressources économiques et fait donc valoir à ce titre les intérêts nationaux. Cependant, terres, main-d'oeuvre, matériel, matériaux, carburant diesel et hydro-électricité sont tous évalués en termes de coût social d'opportunité, c'est-à-dire de leur autre utilisation la plus précieuse. L'analyse désigne la connexion au réseau provincial comme l'option la moins chère, dans l'optique nationale.

L'analyse financière reprend le cheminement de la précédente mais elle s'attarde au coût qu'engagent les choix pour le propriétaire foncier de Seymour Arm, compte tenu des taxes, des subventions, des subsides et des frais réels sur place, sans oublier l'inflation. L'analyse financière diffère de l'analyse économique surtout dans la façon dont sont comptabilisés les prix du carburant diesel et de l'électricité et l'effet des subsides. L'évaluation financière établit elle aussi la connexion comme le choix le moins coûteux pour les habitants de Seymour Arm.

Il reste aux propriétaires à décider s'ils sont disposés à payer le coût résiduel de cette connexion par majoration des taxes selon l'évaluation foncière. Cette méthode semble la plus juste étant donné qu'elle est simple à appliquer et qu'elle suppose, ce qui semble logique, que la valeur ainsi ajoutée à la maison du contribuable et aux améliorations qu'il a faites à sa propriété sera d'autant plus grande qu'était élevée, au départ, la valeur de son bien. Du reste, les propriétaires de lots vacants ne sont pas perdants, puisque la valeur foncière augmente et qu'ils ont désormais la possibilité de faire installer, sans inconvénient, l'électricité.

Si les résidants optent pour cette option, lors du plébiscite qui aura lieu en mai 1984,* il restera encore à organiser et à gérer, jusque dans les moindres détails, tout le projet de façon à pouvoir le mener à bien.

* Le district régional de Columbia Shuswap a tenu un référendum en été 1984 dont on a demandé aux résidents de Seymour Arm s'ils voulaient bien payer plus de taxes afin de couvrir le coût d'une ligne de transmission du réseau provincial. La collectivité a voté contre la motion.

Stage 1

Technical and Cost Evaluation

1. INTRODUCTION

The community of Seymour Arm is located at the northern end of Shuswap Lake in British Columbia, approximately 370 km northeast of Vancouver as shown overleaf on Figure 1-1. It is a mixed community of residences, farms and small businesses but the predominant sector is vacation homes and recreational property.

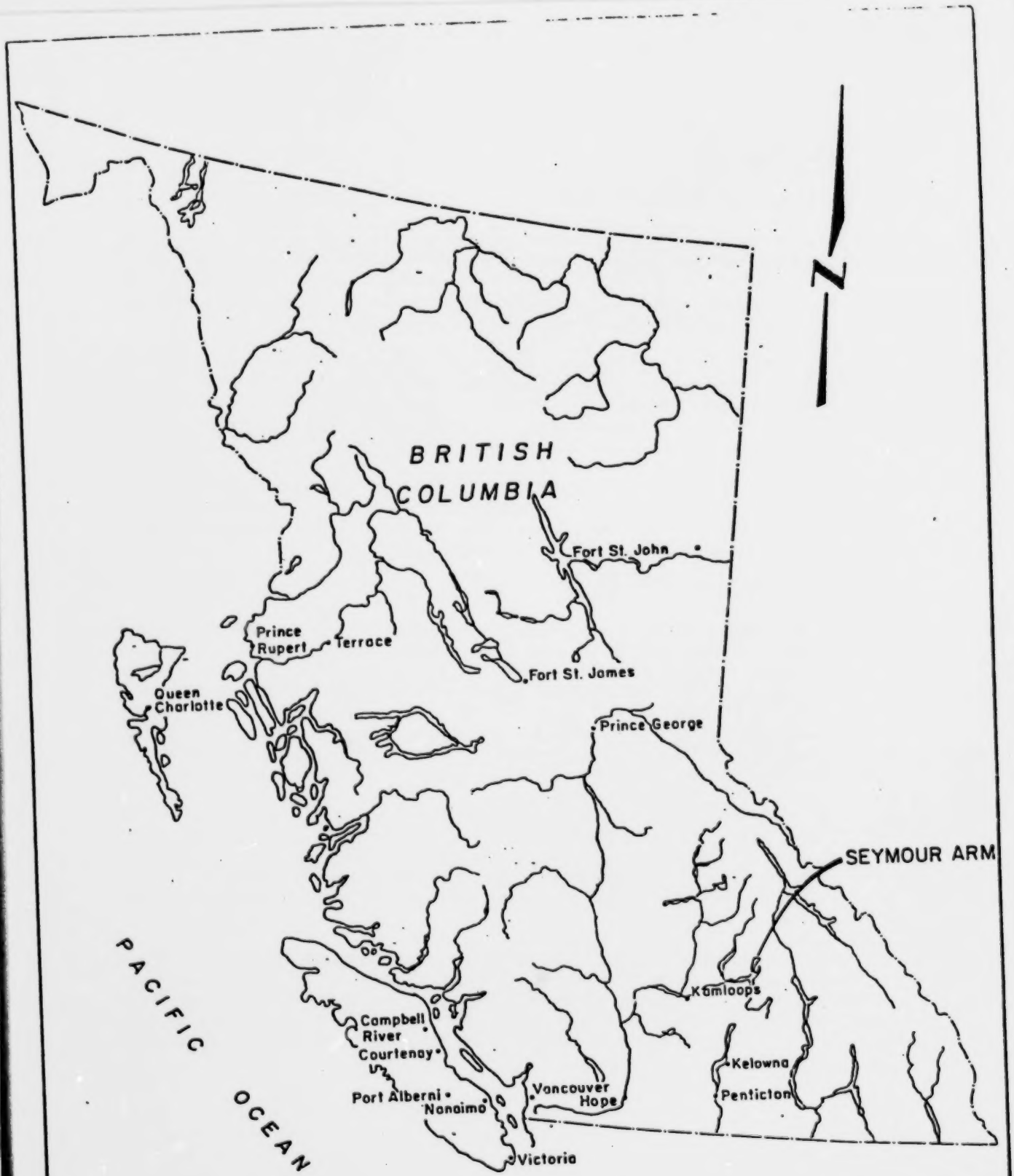
Seymour Arm is a remote community as defined by the Remote Community Demonstration Program (RCDP). It is not connected to either the electrical or natural gas networks, and it has sufficient residents and a degree of permanence to qualify under the conditions of the Program. RCDP funding is available from Energy, Mines and Resources Canada to assist remote communities in reducing their dependence on oil for space heating and electrical generation.

The Program is proceeding in two phases: the first phase provides funds for feasibility studies while the second phase provides funds for demonstration projects. Communities not receiving direct funding will have access to the collected information to enable them to plan an off-oil program.

This report summarizes the first stage of the study carried out under Phase 1 of the RCDP and is intended to evaluate electrical supply options at Seymour Arm.

The second stage of this study will evaluate the economic and financial aspects of the most attractive alternative. The study is funded jointly by the following organizations with their approximate share also shown in parentheses:

Energy, Mines and Resources Canada	(75%)
Seymour Arm Property Owners and Resident Ratepayers Associations	(13%)
Columbia-Shuswap Regional District	(12%)



EVALUATION OF ELECTRICAL SUPPLY ALTERNATIVES AT SEYMOUR ARM, BRITISH COLUMBIA LOCATION PLAN

FIGURE 1-1

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2. BACKGROUND

2.1 HISTORY OF SEYMOUR ARM

The settlement at Seymour Arm has had a long and eventful history. Although the area was first settled in 1810, it was not until the Big Bend Gold Rush of 1861 - 1866 that the community first flourished. Just as the town became established with complete facilities to serve the needs of the gold miners, the gold ran out and the town quickly died.

The second boom at Seymour Arm began about 1910, when the area was promoted for its fruit growing capability. Settlers arrived from England and once again the community flourished. The intervention of World War 1, a tree killing frost, and the increasing costs of transportation led to a gradual decline of population, so that only a few residents maintained their holdings after 1920.

Recently, Seymour Arm has experienced a new and longer lasting development phase, brought on by interest in recreational property and improved access by road and private motorboats. Providing electrical power is another step in ensuring the long term viability of the community.

2.2 ELECTRIFICATION STUDIES

Prior to the inception of this study, the community of Seymour Arm through the Property Owners Association, had made several enquiries regarding improved electrical systems for the community to replace the numerous private generators. In 1981 correspondence was initiated with BC Hydro to determine the costs and feasibility of extending the power line to Seymour Arm from St Ives about 40 km to the south. Several rounds of correspondence have ensued and at each stage some additional information becomes available, and the cost estimate changes. The most recent information is included in this study.

In 1981 a study was commissioned by the Seymour Arm Property Owners to investigate hydro power potential in the area. Solace Energy Ltd of Vancouver completed the work and proposed either a 675 kW or a 1450 kW turbine/generator on Celista Creek about 10 km south of Seymour Arm. The relevant information from this work has been updated and included in this study.

The community also made enquiries about the cost of installing and operating a diesel generating set. Finning Power Products provided the cost of the basic equipment but additional information on completing the system and operating it was compiled as part of this study. The three electrical options of grid connection, hydro power and diesel power form the basis of comparison of the study.

2.3 REMOTE COMMUNITY DEMONSTRATION PROGRAM

The Remote Community Demonstration Program was established in 1982 as part of the National Energy Program. In British Columbia, the first study undertaken was a comprehensive review (SIGMA Engineering, 1983) which catalogued and profiled energy use at remote communities in the province. Subsequently a number of studies were awarded, including this study, which are designed to prove the feasibility of a variety of off-oil* projects, and comprises Phase 1 of the Program.

Phase 2 of the Program will begin in 1984 and will provide funding for demonstration projects. These projects will be designed to assist the remote community directly as well as demonstrate technologies applicable to other remote communities. The Program is structured such that communities receiving Phase 1 funding will not be guaranteed Phase 2 funding, nor will communities applying for Phase 2 funding require Phase 1 projects as a prerequisite.

*and conservation

3. COMMUNITY DESCRIPTION

Seymour Arm is a relatively compact community located at the mouth of the Seymour River and the north end of Shuswap Lake. The community is generally constrained by the lake on the south and the meandering Seymour River on the west, north and east. Additional constraints include the mountains on the west and east. A BC Hydro high voltage transmission line passes about 2.5 km west of the community. Other developments which would likely be included in any electrification of Seymour Arm consist of a group of lakefront properties at Dasnier Bay 1.5 km to the west and the Federated Co-op Six Mile Camp 10 km to the south on the lakeshore.

The landscape of the community is relatively uniform. The land rises gradually from the lakeshore, but dips more steeply on the northern side where the river is confining. Except where clearing has occurred for development, the land is heavily forested.

Figure 1 indicates the location of Seymour Arm and the land ownership distribution. Most of the smaller lots consist of single family residences, either permanent or seasonal. Larger parcels on the east side are generally farms or homesteads of permanent residences while the medium sized (0.6 ha) parcels on the north are part of a newer subdivision, which is largely undeveloped.

The main cultural features of the community include the hotel with its related docking facility and pub, the grass landing strip, provincial park, store, fire hall and community hall. The community infrastructure includes about 18 km of gravel roads (not including access roads) and a gravity water system feeding from a nearby creek. Sewage disposal is by individual septic tanks, garbage disposal is at a nearby site and electricity is generated by individual gas or diesel generators. Thus the community is relatively established with amenities, with the exception of its power supply.

4. ELECTRICAL SUPPLY REQUIREMENTS

4.1 GENERAL

The present and future electrical requirements of Seymour Arm are quite difficult to estimate because of the variable nature of the community. Not only is there a varied usage in the present community (with businesses, farms, permanent and seasonal residences), but the future community usage is dependent on the availability of electric power and the growth that power availability may initiate. Existing residents may increase their power consumption habits if reliable power becomes available at a reasonable cost. Additional residents may also be drawn to the community because power availability will make the area more attractive for permanent and seasonal residences. These aspects are described in this section.

4.2 DEFINING THE POWER SUPPLY AREA

Before any comparison of power supply options is meaningful the area to be electrified must be defined and held consistent for each option under consideration. In this study, that area is described as reaching from the Federated Co-Op Camp at Two Mile Creek in the south to the community of Seymour Arm in the north, covering a distance of 10 km. Included within this area are the settlements at Albas and Dasniers Bay, but specifically excluded (by choice of the residents) is the area across Bughouse Bay from Seymour Arm. The area is defined on Figure 1 by distribution lines.

4.3 PRESENT POWER USE

The present power use at Seymour Arm is based on private generators at all residences and businesses. The total annual power use of 670,000 kWh is summarized in Table 4.1. This is based on the residents estimate of fuel use and a conversion factor of 3.0 kWh/l (13.6 kWh/gal). The existing power generation represents a total power generation expenditure including maintenance of $130,000/year. Table 4.2 shows the additional expenditure on propane for uses other than space heat.

TABLE 4.1

PRESENT POWER USE AND EXPENSES AT SEYMOUR ARM

Category		Rental ($)	Maintenance ($)	Diesel Fuel Used (L)	Electrical Use (kW.h)	Cost per kW.h (¢)	Total Expense ($)
Permanent Residents	(1)	-	300	2,200	6,600	19.6	1,300
	(27)	-	8,100	59,400	178,200	19.6	35,000
Seasonal Residents	(1)	-	50	550	1,650	18.1	300
	(111)	-	5,550	61,000	183,000	18.1	33,300
Commercial							
- Pub		450	-	13,300	40,000	16	6,400
- Hotel		450	-	13,300	40,000	16	6,400
- Store		450	-	4,400	13,000	18.5	2,400
- Community Hall		180	-	1,100	3,300	20	675
- Fire Hall		450	-	2,200	6,600	21	1,400
- Store Marina		90	-	1,100	3,300	18	600
- Hotel Marina		90	-	1,100	3,300	18	600
Logging Camp		-	12,000	60,000	180,000	21.6	39,000
Farms	(1)	600	-	3,300	9,900	21	2,100
	(2)	1,200	-	6,600	19,800		4,200
TOTAL		$3,360	$ 25,650	223,500	670,000	19.4	$ 130,000

NOTES
- Where Rental is shown, maintenance is included.
- Fuel cost locally is $0.45/l ($2.00/gal).
- Figures shown for a single residence are not carried through to the total.
- Source: Seymour Arm Property Owners Association.

TABLE 4.2

USE OF PROPANE AT SEYMOUR ARM

FOR COOKING, REFRIGERATION AND LIGHTING

	Propane Used (L)	Value $/yr	Electrical Equivalent (kW.h)
Permanent Residents	15,700	5,175	72,300
Seasonal Residents	16,800	5,550	77,300
Commercial	12,100	4,000	55,700
Logging Camp	19,700	6,500	90,700
Farms	3,000	1,000	13,800
	67,300	22,225	309,800

NOTE: Electrical Equivalent is based upon a 60% conversion efficiency from propane to electricity used for cooking or cooling.

4.4 POWER USE BY PRESENT COMMUNITY WITH GRID CONNECTION

If a grid connection were implemented at Seymour Arm, or there were another system by which power availability was effectively unlimited, the demand for power by the community would certainly increase. The magnitude of the increase depends on the increased use of electricity through existing appliances and the degree of changeover from fuel using appliances to electric appliances. The calculation is based upon the permanent residences attaining the provincial average for electricity use with the seasonal residences using 40% of the provincial average. Farms would use twice the provincial average while commercial establishments and the logging camp would use the same amount of power as they do now. These estimates are shown on Table 4.3 and would result in a peak demand of 490 $\pm$ kW.

TABLE 4.3

Estimated Power Use with Grid Connection

Category		Estimated Electrical Use (kWh)
Permanent Residences	27 @ 9000 kWh	243,000
Seasonal Residences	111 @ 4000 kWh	444,000
Commercial		109,500
Logging Camp		180,000
Farms	2 @ 18,000 kWh	36,000
		1,012,500

4.5 POWER USE BY FUTURE COMMUNITY WITH GRID CONNECTION

In order to estimate future power use, which is required to determine system design, some assumptions must be made about the growth rate in the community. The growth rate must anticipate the normal community growth plus the extra growth which is induced by the availability of a convenient power supply.

For the purpose of this study, the growth horizon is assumed to be 20 years. That is, the system will be designed for the peak load that will occur in 20 years time. Any further growth horizon could lead to a severe under or over estimate of the system costs and result in the community paying a disproportionate share of the fair costs. The growth forecast is based on the following:

Years 1 - 5
- Community Estimate of Doubling of Permanent Residents, 35% increase in Seasonal Residents.
- No Change in Commercial or Logging Camp Loads
- Average Growth 6.7%/year

Years 5 - 10
- Overall Growth between above and below = 4.8%/year

Years 10 - 20
- Overall Growth Similar to the BC Hydro long term provincial forecast of 3.4%.

This results in a system of 1,770,000 kWh annual load in 10 years and 2,470,000 kWh annual load in 20 years, using Table 4.1 as a base.

As a comparison, if all the existing subdivided lots (400) were occupied, with 25% permanent and 75% seasonal residents, the total annual residential load would be 2,100,000 kWh, plus additional use for the logging camp. What the forecast does not account for is the possibility of subdividing some of the larger tracts of land near the lakeshore, in which case the number of properties would increase by several hundred. The electrical load would increase proportionately if these lots were developed.

4.6 PEAK POWER DEMANDS

Much of the economics of the Seymour Arm electrical supply system will be determined by the total load estimates above, but the peak loads will be responsible for much of the technical system design. Peak load forecasting is complicated by the diverse nature of the community.

There are several categories of power use in Seymour Arm, each with its own load pattern. The permanent residents would use power according to the seasons, with highest demand in the winter at dinner hour. Seasonal residences, which are mainly occupied from Spring through Fall on weekends would exhibit a dinner hour peak, but the total load from this group would depend more on the number of residences occupied than on the time of year. Commercial establishments would likely show a load pattern which varies with the business activity, which would peak in summer at Seymour Arm. The energy pattern for the logging camps would be different also, as its peak would be in winter but in the middle of the night when up to 12 logging trucks are plugged into heaters. The anticipated pattern of energy use is shown in Figure 2. The resulting peak load of 400 - 500 kW in 1983 is expected to grow to about 950 kW over 20 years. Allowing a 50% margin of safety the system would be designed for 1425 kW. The diversity of the community and the increase in summer population results in a system peak load in summer, even if electric heating is used.

The above system sizing would be mainly considered for the transmission and distribution lines, as excess capacity can be built in relatively easily. The sizing of the power source, if it is to be a hydro power or other independent system, would consider other factors relating to reliability and power availability before a potentially overbuilt system could be considered.

5. ELECTRICAL SUPPLY ALTERNATIVES

5.1 GENERAL

Seymour Arm has a number of options available for electrical supply, and it is the main objective of this report to analyse these options. The residents themselves have initiated work in several areas, notably with the study of a small hydro power system, a grid connection and a central diesel generating plant. Other sources of renewable energy, such as wind, solar and geothermal energy, are not considered viable. The residents already make considerable use of wood for space heating, so their main concern is for an electrical power supply which is available at a lower cost then the diesel generated power they now use.

5.2 GRID CONNECTION

The possibility of a connection to the BC Hydro grid system has been considered by the Seymour Arm residents over the past several years and it is one of the major options under consideration in this study. With the relatively unlimited amount of power available it continues to be one of the most attractive schemes. It is a highly reliable system with the only uncertainty caused by the weather and the risk of service interruptions to the transmission line. These have been recognized in proposals to Seymour Arm by BC Hydro and would be of major consequence if the service vehicle could not reach the site of the problem due to snow on the road or other adverse weather.

Despite the fact that 500 kV lines from the Mica Project pass within 3 km of the community, the cost of stepping down this voltage to normal distribution loads would be prohibitive. Accordingly the only alternative is to extend the line which currently ends at St Ives at the mouth of the Seymour Arm of Shuswap Lake. This would involve some upgrading of the existing line to St Ives, then continuing the three phase line to Seymour Arm. The line would have a capacity of 1750 kVA (About 1500 - 1600 kW) and the cost estimate from BC Hydro has been included in Section 6.

A number of other considerations would apply to the grid connection proposal. Although technically straight forward the work does present some legal and financial problems. Legal problems include the securing of easements for a power line (most of which is over Crown Land) and the establishment of a body to administrate the construction and community financial contribution. The complications arise because of the nature of the funding contributions as discussed in Section 7.

The construction aspects of the project could become administratively complex; however, worthwhile savings may occur. The cost estimate presented by BC Hydro is based on construction by their own forces and may not reflect the savings possible with competitive bidding, especially under current market conditions. In addition, some aspects of the project, such as the clearing, may be taken on by the community at further savings.

The grid connection itself, once the various steps have been taken to implement it, will be relatively simple. The three phase line will extend mostly along the roadway from St Ives to Seymour Arm. Conventional pole line construction techniques would be used as accessibility can be provided at most points. A three phase line was selected to allow for expansion in the system, as a single phase is only adequate for the existing loads and little more. A three phase line will also allow for three phase motors to be used, such as are used at the logging camp and potentially those motors used for irrigation pumps at the farms. Once within the community, distribution would be at a single phase, with lines laid out to serve the area shown in Figure 1.

5.3 HYDRO POWER SYSTEM

Hydro power is a potential alternative energy source for Seymour Arm. It would provide an independent system in which the community would own, operate and maintain the supply and distribution system. In addition, the community would be responsible for reading meters and collecting payments to amortize the system.

In the situation at Seymour Arm there are both positive and negative aspects to a hydro power system. On the plus side, there is security against rising power costs and an independence from outside influences. On the minus side, there are the problems associated with the actual administration and operation of the system and the legal problems of establishing a utility. Technically, there are limitations to the system capacity imposed by the turbine/generator rating and the availability of water. Although present predicted peak demand is within the system capacity, load growth will eventually exceed the system capacity. Therefore, power shortages must be made up by either load restrictions or the use of standby diesel generation. Load restrictions may not always be effective as they are difficult to enforce and they are of little use when the entire system must be shut down for repairs or maintenance. Accordingly a standby diesel generation system is considered essential, because the eventual reliance of the community on electric power will warrant it. Details of a diesel power system, similar to a standby system, are described in Section 5.4.

In 1981, the Seymour Arm Resident Ratepayers Association commissioned Solace Energy of Vancouver to evaluate the hydro power potential of the area. The report concluded that a 675 kW scheme on Celista Creek was the most attractive. The scheme contained the following features to take advantage of the steep terrain around Albas Falls:

- Static Head	=	290	ft	(88 m)
- Penstock Length	=	2250	ft	(685 m)
- Design Flow	=	35	cfs	(1 m^3/s)
- Turbine	=	675	kW	Horizontal Francis
- Transmission Line	=	4.3	Miles	(6.9 km) to Seymour Arm

- Intake = Headgate diversion to settling pond and secondary diversion from Blueberry Creek

- Power Availability = 5,800,000 kW.h/yr
- Estimated Cost (1981) = $1,418,000

In accordance with the terms of reference of this report the above scheme was reanalysed in terms of its technical merits and costs. This information is detailed in Section 6 and forms the basis of comparing the power supply options at Seymour Arm, while the layout is shown in Figure 4. The proposed hydro power system would need to tie in to a community distribution system. This has been costed at the same price as the distribution system proposed by B C Hydro. The distribution system would be tied in to the standby diesel power plant, located within the community, which would be capable of operating independently or synchronized with the small hydro power plant.

5.4 CENTRAL DIESEL POWER SYSTEM

The remaining power supply option available to Seymour Arm is to install a central diesel power plant. From the outset it is recognized that this option is going to involve high costs for operation although moderate initial costs are possible. The option is included for comparison with the other systems evaluated in this study and to provide the costing information necessary for the standby power to a hydro power scheme. It is also a means of attaching a value to the individual power supplies in use at Seymour Arm. The Seymour Arm residents have previously made enquiries for the costs of a diesel generator set. In this study we have taken these as a starting point and added in the capital costs of a powerhouse and distribution system. The costs of operation and maintenance have been calculated separately and projected over the long term. Although allowance has been made for unrestricted power use, in reality the system would probably have load restrictions, and the use of electric water heaters, ranges and space heaters could be prohibited. If residents were paying the full cost of the electric power, fuel using devices would be more economical than their electric counterparts and electric power use would be limited to lights and appliances.

A central diesel power system would consist of a powerhouse located within the community, at least two generator sets within the building and a distribution system.

It would not be practical to connect in the logging camp as it already has a similar power system. The costs, which are summarized in Section 6, are dominated by the cost of fuel and the marginal cost of power generation is never less than the fuel cost. The generators and powerhouse would have to be installed as a backup to a hydro power system, and there would also need to be an interconnection facility to allow the diesels to run in isolation or to load share. A typical system layout is shown in Figure 5.

6. COSTING

6.1 GENERAL

The viability of any long term power supply option for Seymour Arm will depend on the ultimate cost to the consumers. The factors involved are complicated by the location, the limitations of each system and the uncertainty of future load growth in the area. In addition a number of intangibles is involved with each system, which will effect the convenience, capacity and indirectly the cost.

6.2 METHODOLOGY

System costs were analysed on the basis of installation costs (capital costs) and the operating costs. Previous work initiated by the community has provided enough information to initiate cost estimates, but this information has been supplemented by the analysis in this report. The result is a capital cost to provide a power supply system to Seymour Arm. For comparative purposes, the capital costs have been amortized and further divided by the estimated number of consumers to provide annual consumer costs of power.

The operating costs of each system have also been calculated. Operating costs are defined as those costs which occur only if power is used. It must be assumed that when operating, all portions of the community use power so as to evenly distribute the operating costs. This assumption prevents those properties which are connected to power, but not using it, from avoiding their share of overhead costs which are roughly fixed once any amount of power is provided.

The combined system costs are affected by the total number of kilowatt hours of power generated. Operating costs increase with increasing system loads. Therefore each additional kilowatt hour used costs more, but the exact cost varies with the system and with the operating level. In contrast, fixed capital costs remain fixed as long as the system capacity is not exceeded. As more kilowatt hours of power are used within the system capacity, the average cost per kilowatt hour will decrease. Thus it is important to evaluate the power needs and estimate the power usage in the community. It is also important to be able to compare the systems at various levels of load. These comparisons are discussed further in Section 7 and Appendix 2.

6.3 SYSTEM COSTS

Grid Connection

The grid connection costs have been estimated with the assistance of the BC Hydro District Office responsible for the Seymour Arm area. The requirements include existing system upgrading, a three phase line from St Ives to Seymour Arm with a capacity of 1650 kVa and a local distribution system. The costs are somewhat preliminary based on BC Hydro experience in the area and taking into account the rugged terrain. The costs would have to be confirmed after route surveys and more detailed engineering could provide a better description of the project.

Although the cost estimate of $1.5 million is relatively high, there are a number of factors which could make the costs more attractive. The most important factor in cost reduction (to the residents of Seymour Arm) is the Rural Electrification Assistance Grant (REA). This is a contribution by BC Hydro toward the cost of construction of the project which would amount to $11,000 for each principal residence, $15,800 for each farm and $400 for each non principal residence. Commercial establishments would be granted an allowance of $11,000 or 4 times the estimated annual revenue, whichever is greater. Before the grant is applied, a survey would be done to determine the category of each proposed connection. The difference between the construction costs and the REA grant must be made up by the community.

The cost estimates may also be reduced by the participation of the community in the project. For example, clearing could be handled separately using winter works funds and private subcontractors could bid on the construction of the power line to BC Hydro standards. Considering the present slowness in the construction industry prices lower than the estimates may result. The outcome of any cost savings will apply directly to the contribution by the community as any grant from BC Hydro will remain in place.

The BC Telephone Company also has a policy pertaining to the construction of new systems. A telephone system for Seymour Arm is presently under study and because the telephone lines share pole space with the electrical lines, the BC Telephone Company makes a contribution of 40% of the cost of the distribution poles. At Seymour Arm there may be about 200 distribution poles costing $500 each, so a contribution of about $40,000 from BC Tel could be expected.

Additional grants may be possible, but they are by no means a certainty. The community may be eligible for federal programs which encourage local initiative. Assistance in these areas could be sought once the level of participation by the community is decided and the optimal power supply system is chosen.

The capital and annual cost estimates for the grid connection are shown in Table 6.1 Various assumptions have been made in calculating the annual cost estimate such as the rate of inflation, growth rate in power usage and discount rate. The sensitivity of the cost of these assumptions is shown in the figures at the end of Appendix 2, where present values of all three systems are shown. A parameter that is more difficult to estimate is the property values in the area. If the real value of assessments increases through additional construction (encouraged by readily available power) then the share of each property owner to pay the fixed costs of the power system will decrease. Further discussions of the financing of the project are included in Section 7.

Hydro Power System

The hydro power system as proposed by Solace Energy Ltd has been evaluated for both Option A (1400 kW) and Option B (600 kW). Considering the size of the community and the hydrology of Celista Creek the estimates bear

TABLE 6.1

COST COMPARISION OF ELECTRICAL SUPPLY ALTERNATIVES AT SE [illegible]
OPTION A: GRID TIE-IN
DISCOUNT RATE (%) = 13
PROJECTED ANNUAL POWER GROWTH RATE (%) = 4.4

DESCRIPTION OF ITEM	CAPITAL COST			
	QTY	UNIT	UNIT COST	AMOUNT
CLEARING	1	lump	150000.00	150000.00
SURVEYING	1	lump	15000.00	15000.00
SYSTEM UPGRADE AT ST. IVES	1	lump	175000.00	175000.00
3 PHASE LINE FROM ST. IVES	1	lump	979410.00	979410.00
DISTRIBUTION AT TOWN SITE	1	lump	225000.00	225000.00
CONNECTIONS - STANDARD	120	each	10.00	1200.00
- SECONDARY SPAN	20	each	498.00	9960.00
- PRIMARY SPAN	9	each	1144.00	10296.00
SUBTOTAL				1565866.00

DESCRIPTION OF ITEM	PRESENT VALUE OF ANNUAL COSTS			
	ANNUAL COST YR 1	TIME HORIZON	GROWTH RATE (%)	AMOUNT
REA SURCHARGE	18000.00	5	0	71540.48
COST OF POWER	46400.00	40	8	1778733.76
SUBTOTAL				1850274.24

TOTAL COST FOR THE GRID SYSTEM 3416140.24

out the previous conclusion that the smaller scheme would be more economical. However, a number of changes have been made to the cost estimate to align it with the other estimates including:

- allowance for distribution costs;
- allowance for a standby diesel power plant;
- allowance for operation and maintenance;
- revision of hydrology;
- provision for growth in the community;
- refinement of basic cost estimate.

The distribution line cost was previously not included in the hydro power cost estimate and has been allowed for at the same rate as the BC Hydro estimate. Approximately 12 km of line could be built for the indicated amount.

The standby diesel power plant was not allowed for in the earlier estimate. Experience with hydro power units would indicate that there should always be a backup system to allow for maintenance shutdowns, repairs and water shortages. Accordingly the cost of a diesel unit based on the diesel only costs discussed later in this section is included. Operating costs are included for the times when diesel power would be required.

Operating and maintenance costs were not previously included but they are an essential part of even a hydro power system. The key to system reliability is preventative maintenance comprising regular inspection, proper lubrication and attention to small problems. An annual allowance of 2% of the capital costs is included covering system operator time and professional inspection.

The hydrology has been revised because of a discrepancy in the assumption of 10 cfs (0.28 m^3/s) contribution from the Blueberry Creek diversion. Considering the relative drainage areas of Blueberry Creek and Celista Creek, Blueberry Creek should only have 7% of the Celista flow which in winter would be 2.5 cfs (.07 m^3/s). In fact, the actual amount would likely be less because there is no storage on Blueberry, as opposed to the significant storage of Humamilt Lake, which takes up about one-third of the length of Celista Creek.

Therefore the hydro power system has been evaluated without the Blueberry diversion. Also considered in the analysis is the fact that there will be times when the mean monthly flow in winter is not available for generation. Flows above the system design flows are not available for power generation, while flows below the system design flow limit the output. These details are covered in Figure 3.

Community growth becomes a factor because once the hydro power plant capacity is exceeded there is little potential for system expansion. Additional power requirements are assumed to be made up with diesel generation. The growth projections shown in the figures at the end of this section indicate the rapidly increasing cost of hydro power at high community growth rates. It is to be expected that in the long run the community power costs will begin to approach those of a system with only a diesel power plant.

The construction cost estimate for the hydro power scheme was reviewed and some changes made. No adjustment was made for inflation because the construction market may yield the same or lower prices than two years ago

(mid 1981). However, the penstock cost has been increased; the intake cost has been left the same, but the secondary diversion from Blueberry Creek deleted; the powerhouse cost increased and provision for an access road made. Reference to the map provided in the Solace report indicates a powerhouse beside the road but the penstock measures about 1000 m long. As roads are less expensive than penstocks, we have assumed that an access road is provided to the base of the falls and that the actual penstock length is as stated in the report (685 m).

The other major adjustment involves the power output of the scheme. The stated power capacity of 5,800,000 kWh/yr involves a power usage of 98% which is considered unrealistic and also includes a contribution from Blueberry Creek. Instead, the maximum power is based on the available water in Celista Creek only (through the period of record) and ranges from 20% of full capacity in March to 100% in May. To the resulting power potential of 5,140,000 kWh/yr is applied a 10% reduction for maintenance and repairs, yielding an average annual power availability of 4,625,800 kWh. The cost and power estimates are shown on Table 6.2 and Figure 3.

Diesel Power System

The diesel power option is costed so as to provide an estimate of the value of power the way it is presently generated. The independent generators used at Seymour Arm have no significant distribution lines nor do they have a direct maintenance cost (operator time). However, other expenses such as repairs and fuel would have proportionately higher costs because of the small scale of the units. Thus a comparison is useful in order to attach a value to the present system of power generation and provide an estimate of the necessary standby diesel power system for a hydro power unit.

The capital cost estimate is based on estimated prices for generators, a powerhouse and the distribution system. Allowance has also been made for paralleling the diesel system with a hydro power system.

The operating cost estimate is more difficult to determine, because of the uncertainty involved with fuel prices and future loads. In the figures at the end of this section, various combinations of discount rate, inflation rate and power growth rate are applied. In every case the diesel power system is the most sensitive to high rates of load growth, because increasing rates of power at inflated costs reflect in higher present values. Future expansions of the diesel power system are relatively easy to handle by replacing worn units with larger ones or adding new units, while infrastructure costs are fixed.

Present values of the diesel power system are calculated because the operating costs are so high in relation to the capital costs. Future system costs are calculated based on the assumed power usage rate and the assumed fuel price at the time. Most estimates foresee that in the long term fuel prices will continue to rise at about 2% above the rate of inflation. These future costs are then returned to present value at the discount rate. The future loads are calculated for several possibilities, although the most probable growth rate is predicted in Section 4 as 4.4% over 20 years. The growth rate has been based on the assumed availability of power; however, the high cost of diesel power to the consumer may have a depressing effect on power consumption. A summary of the diesel power system costs is shown in Table 6.3.

TABLE 6.2

COST COMPARISION OF ELECTRICAL SUPPLY ALTERNATIVES AT SEYMOUR ARM
OPTION C: SMALL HYDRO (SCHEME B) WITH DIESEL BACKUP
DISCOUNT RATE (%) = 13
PROJECTED ANNUAL POWER GROWTH RATE (%) = 4.4

DESCRIPTION OF ITEM	CAPITAL COST			
	QTY	UNIT	UNIT COST	AMOUNT
SMALL HYDRO UNIT (SCHEME B)				
- TURBINE,GEN. ECT	1	lump	400000.00	400000.00
- PENSTOCK	685	meters	820.00	561700.00
- TRANSMISSION LINE	7	km	30000.00	210000.00
- SWITCHYARD EQUIP.	1	lump	75000.00	100000.00
- STATION ELECT.	1	lump	130000.00	130000.00
- POWERHOUSE & TAIL.	1	lump	84000.00	50000.00
- HEADGATE,ECT	1	lump	70000.00	70000.00
- ACCESS ROAD	1	lump	15000.00	15000.00
SUBTOTAL				1536700.00
Contingency				256000.00
SUBTOTAL				1792700.00
Engineering and administration				225000.00
TOTAL COST FOR 650 kW SMALL HYDRO UNIT				2017700.00

DESCRIPTION OF ITEM	CAPITAL COST			
	QTY	UNIT	UNIT COST	AMOUNT
DIESEL UNIT BACKUP				
- DIESEL UNIT	2	each	60000.00	120000.00
- POWERHOUSE	1	lump	20000.00	20000.00
- STATION ELECT.	1	lump	10000.00	10000.00
DISTRIBUTION AT TOWN SITE	1	lump	225000.00	225000.00
CONNECTIONS - STANDARD	120	each	10.00	1200.00
- SECONDARY SPAN	20	each	498.00	9960.00
- PRIMARY SPAN	9	each	1144.00	10296.00
TOTAL COST OF DIESELS, DISTRIBUTION AND CONNECTIONS				396456.00

DESCRIPTION OF ITEM	PRESENT VALUE OF ANNUAL COSTS			
	ANNUAL COST [illegible]	TIME HORIZON	GROWTH RATE (%	AMOUNT
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

SUBTOTAL [illegible]

TOTAL COST FOR THE SMALL HYDRO SYSTEM 3738900.18

TABLE 3.3

COST OF PROVISION OF ELECTRICAL SUPPLY ALTERNATIVES AT SEYMOUR [illegible]
OPTION 2: DIESEL GENERATION
DISCOUNT RATE (%) = 13
PROJECTED ANNUAL POWER GROWTH RATE (%) = 4.4

DESCRIPTION OF ITEM	CAPITAL COST QTY	UNIT	UNIT COST	AMOUNT
DIESEL STATION - DIESEL UNIT	2	each	60000.00	120000.00
- POWERHOUSE	1	lump	20000.00	20000.00
- STATION ELECT.	1	lump	10000.00	10000.00
TRANSMISSION LINE	1	km	35000.00	35000.00
DISTRIBUTION AT TOWNSITE	1	lump	225000.00	225000.00
CONNECTIONS - STANDARD	120	each	10.00	1200.00
- SECONDARY SPAN	20	each	198.00	3960.00
- PRIMARY SPAN	9	each	1144.00	10296.00
SUBTOTAL				425456.00

DESCRIPTION OF ITEM	PRESENT VALUE OF ANNUAL COSTS ANNUAL COST YR 1	TIME HORIZON	GROWTH RATE (%)	AMOUNT
MAINTENANCE OF DIESEL UNIT	15000.00	40	6	223385.63
MAINTENANCE OF POWER LINE	4000.00	40	6	59569.50
COST OF DIESEL FUEL	152000.00	40	8	5826886.44
SUBTOTAL				6109841.58
TOTAL COST FOR THE DIESEL SYSTEM				6535297.58

7. METHODS OF FINANCING ELECTRICAL SUPPLY SYSTEMS

7.1 GENERAL

Throughout this report the emphasis has been placed on providing cost estimates of the three principal means of power supply to Seymour Arm. Each of the three systems (grid connection, hydro power and diesel power) has a significantly different method of calculating the present value of the capital costs. Similarly the methods of financing systems may differ in each case. A preliminary analysis of these mechanisms is provided in this Section, although a more thorough analysis will be provided in the second stage of the study.

7.2 ECONOMIC AND FINANCIAL COSTS

In most situations, there are economic and financial costs associated with the development or construction of a project. In a simplistic economy, where a dollar spent bought exactly one dollar of goods and services the economic and financial costs would be the same.

The real world and the situation at Seymour Arm are much different. The Canadian economy is complicated by taxes, subsidies, transfer payments and other monetary movements which can alter the apparent attractiveness of certain projects. For any electrical system at Seymour Arm, these complications include the following:

- oil prices to the consumer are subsized in relation to world oil prices, but are still comprised of a high level of taxation;
- grants are available from BC Hydro and others to affect some of the construction costs of a grid connection;
- grants may be available through special programs to assist off oil projects, such as a small hydro power project, but only upon a successful submission in competition with other projects;
- some taxation benefits exist for off oil projects, but these may only apply to certain aspects of the project and they depend on having taxable income to shelter;
- different financing schemes may be proposed which will yield different long term costs to the consumer;
- inflation rates may alter the relative attractiveness of different power supply options in future years.

Initially, this study is aimed at evaluating what may be termed the financial costs, which here are defined as the net costs to the consumer at Seymour Arm. The community is mainly interested in the "out of pocket" charges the residents will face for any power system and the complications mentioned above can be summarized by the annual costs for power which they pay. A proposal for financing is presented in Appendix 3.

7.3 FINANCIAL COSTS OF THE POWER SUPPLY OPTIONS AT SEYMOUR ARM

The factors assumed in each financial cost estimate are outlined in this section. For each system they are:

Grid Connection

The total grid connection costs have been reduced by the applicable allowances from BC Hydro (the REA grant) and from BC Tel (the pole cost sharing grant). No additional grant was assumed. The balance of the construction costs is assumed to be financed by the property owners through Regional District taxation.

Payment of the outstanding grid connection costs through taxation is an effective method of equitably distributing the financial burden of the grid connection. Through the Municipal Financing Authority, the Regional District can borrow funds on behalf of the community at Seymour Arm at attractive rates, then recover the money over a number of years. The tax would be based on property assessments, so that owners of subdividable land will pay based on the size of their parcel; homeowners will pay based on the value of the home (which reflects the amount of power it uses); and businesses will pay based upon their assessed values. The advantages of the system include:

- the costs of the grid connection are spread over time so that people moving away are not penalized;
- owners of speculative land pay a share of the increased value the power system has brought to the land;
- as more residences are constructed, the value of the total community assessment will increase and the cost to each individual will decrease.

The exact conditions of the tax plan would need to be decided by the community and supported by a referendum.

In addition to the annual charge on property, there will be the usual BC Hydro charges to pay based on:

$6.00 every two months connection charge

$10.00 per month REA fee (for a maximum of 60 months). This charge is waived if the value of power used exceeds $10.00

5.5¢/kWh for the first 550 kWh in a billing period

4.5¢/kWh for all additional power.

Based on the above, and assuming that the 138 homes are assessed and that the permanent residents use the provincial average for electricity while seasonal residents use 40% of the average a typical annual cost for power would be as shown in Table 7.1. The result is based on the assumptions of Appendix 3.

TABLE 7.1

CONSUMER COSTS OF POWER
GRID CONNECTION (1983)

Permanent Resident

Annual Property Tax for Grid Connection (Financed at 25 years, 12%)	$ 329.00
Connection Fee	36.00
REA Fee	N/A
Power Usage (9000 kWh/yr)	438.00
	$ 803.00

Seasonal Resident

Annual Property Tax for Grid Connection	$ 303.00
Connection Fee	36.00
REA Fee	N/A
Power Usage (4000 kWh)	213.00
	$ 552.00

Note: The value of the tax portion of the bill would decrease if future developments widened the tax base. The logging camp is assessed 17½% of the capital costs based on a share of estimated total consumption. Undeveloped properties are assessed a flat rate of $253/year.

Hydro Power System

The determination of the financial costs of a hydro power system is complicated by a higher degree of uncertainty in terms of construction cost and the level of financial assistance available. The annual power usage will also have an influence on the costs depending on the total power usage and the amount of diesel power required.

Although grants may be available from the Remote Community Demonstration Program, these are by no means guaranteed. The level of assistance could range from zero to several hundred thousand dollars. Tax write offs would not be a factor because the utility structure would not have other sources of income to shelter. Therefore the analysis on Table 7.2 assumes no financial assistance and that capital costs are paid for through taxation. Operating costs are difficult to determine and could range from the salary of the operator at a minimum up to the costs of operation, repairs and fuel. The operational costs would be variable and difficult to predict in detail until some experience is obtained with the system. System load growth would also change the operating costs with time. Table 7.2 below presents the consumer costs on an average annual basis for the early years of the system.

TABLE 7.2
CONSUMER COSTS OF POWER
HYDRO POWER SYSTEM (1983)

Permanent Resident	
Annual Property Tax for Hydro Power System (Financed at 25 yrs, 12%)	$ 749.00
Connection Fee (to support fixed operating costs)	373.00
Power Usage (Assuming diesel supplies 10% of power needs and is factored into all power bills and that hydro power usage pays for a repair contingency fund at 1¢/kWh) 9000 kWh	215.00
	$ 1,337.00
Seasonal Resident	
Annual Property Tax	$ 690.00
Connection Fee	373.00
Power Usage (4000 kWh)	96.00
	$ 1,159.00

Note: Conditions of Table 7.1 apply. Undeveloped properties are assessed a flat rate of $576 per year.

Diesel Power System

The diesel power system features much lower capital costs but higher operating costs relating closely to the cost of fuel and the amount of power used. There is no reason to expect any subsidies for this system. Operating costs are based on the average cost for the community split on a cost per kWh basis, as shown in Table 7.3.

TABLE 7.3
CONSUMER COSTS OF POWER
DIESEL POWER SYSTEM (1983)

Permanent Resident	
Annual Property Tax for Diesel Power System (Financed at 25 yrs, 12%)	$ 162.00
Connection Fee (to support fixed operating costs)	137.00
Power Usage (covers fuel and maintenance) 9000 kWh @ .15¢/kWh	1,350.00
	$ 1,649.00
Seasonal Resident	
Annual Property Tax	$ 149.00
Connection Fee	137.00
Power Usage (4000 kWh)	600.00
	$ 886.00

Note: There is no assessment to the logging camp as they have a diesel power system already. Undeveloped properties are assessed a flat rate of $117 per year.

7.4 FUTURE COSTS OF POWER

The analysis of future costs of power is important in this study because each alternative power system is affected differently by load growth. The assumptions made include an increase of 4% per year in the improvement assessment value and power load of the community, 2% net inflation in electricity and fuel costs and a 10 year time horizon. The comparisons are shown in Tables 7.4, 7.5, and 7.6 and 1983 constant dollars are used.

TABLE 7.4
CONSUMER COSTS OF POWER
GRID CONNECTION (1993)

Permanent Resident	
Annual Property Tax for Grid Connection (based on 48% higher assessment for improvements)	$ 304.00
Connection Fee (22% higher)	44.00
REA Fee (expires after 5 years)	-
Power Usage (9000 kWh/yr) (22% higher)	535.00
	$ 883.00
Seasonal Resident	
Annual Property Tax	$ 286.00
Connection Fee	44.00
REA Fee	-
Power Usage (4000 kWh/yr)	260.00
	$ 590.00

Note: Undeveloped properties are still paying $253/year.

TABLE 7.5

CONSUMER COSTS OF POWER

HYDRO POWER SYSTEM (1993)

Permanent Resident	
Annual Property Tax for Hydro Power System	$ 692.00
Connection Fee (partial reduction)	344.00
Power Usage (Assuming diesel supplies 10% of power needs and is factored into all power bills and that hydro power usage pays for a repair contingency fund at 1¢/kWh) 9000 kWh	246.00
	$ 1,282.00
Seasonal Resident	
Annual Property Tax	$ 652.00
Connection Fee	344.00
Power Usage (4000 kWh)	109.00
	$ 1,105.00

Note: Undeveloped properties are still paying $576 per year

TABLE 7.6

EXPECTED COSTS OF POWER

DIESEL POWER SYSTEM (1993)

Permanent Resident	
Annual Property Tax for Diesel Power System	$ 147.00
Connection Fee	126.00
Power Usage - covers fuel and maintenance 22% increase (9000 kWh)	1,650.00
	$ 1,923.00
Seasonal Resident	
Annual Property Tax	$ 138.00
Connection Fee	126.00
Power Usage (4000 kWh)	732.00
	$ 996.00

8. FINDINGS AND RECOMMENDATIONS

8.1 GENERAL

The study has examined three options of supplying electrical power to Seymour Arm and presented a scenario for determining the costs of the system as seen by the eventual consumers of the power. In considering any of the power supply options a high degree of reliability is ensured because in all instances a proven technology is employed. In terms of system failures, the longest failures could occur with the grid connection option, because there is no standby system and adverse weather conditions could prevent a transmission line problem from being repaired immediately. However, there could be fewer interruptions than with other systems.

In this section some means of approaching the decision of which power system to select are discussed. There are different ways of analysing each system which can affect the apparent attractiveness of the system and there are intangible factors which are difficult to quantify, but which make a significant impact on the acceptability of each system.

8.2 SYSTEM RELIABILITY

System reliability is always a concern with any power system. Any new system will have to be available a high percentage of the time, otherwise user dissatisfaction will grow despite the fact that the residents are accustomed to having an unreliable power source with the present system of individual generators and an assortment of fuel using appliances. It is conceived that any of the new systems will have a high enough level of reliability that minor variations between them are not worthy of further consideration.

8.3 SYSTEM EXPANSION

A consideration in the analysis of power needs at Seymour Arm is the capability of expanding the system to meet future load demands. In this regard, each power supply option has different limitations.

The grid connection alternative has the greatest flexibility, because its installed capacity initially exceeds the requirements for the community by a wide margin, and for only a moderate extra cost. If in future the community requires additional power, it would be solely the responsibility of BC Hydro to provide increased capacity. If a single large industrial concern was the reason for expansion, a cost share would be arranged between the industry and BC Hydro.

The hydro power system is limited by its installed capacity of 675 kW and it is also subject to other limitations. In winter, low flows in the creek may lower the peak output to 130kW and the average monthly maximum output to 64% of full capacity. This would occur when demands may be high, especially if more permanent residents settle and if electric heating was installed. The power shortfall would have to be made up with load restrictions or diesel generation. The single unit generating plant would require a shut down for maintenance or

repair occasionally and during these times full diesel generation would be required. The system is vulnerable to some natural hazards and if problems arose that took time to repair, the diesel power plant would again be required full time. As the system demands grow, even peak hydro power capacity may be insufficient and the diesel power plant would again be required for peaking capacity. Due to the shortage of developable hydro power sites in the area, the capacity limitations of Celista Creek and the low load factor of any expanded system, further increases in the hydro power capacity would be uneconomic.

The diesel power system is only limited by the size of units installed. However, as the fixed costs are relatively low compared to the operating costs, flexibility is achieved by adding generating units or installing larger units when the original units are due for replacement. The price paid for the flexibility is the vulnerability of the system to rapid price increases in fuel oil.

8.4 SYSTEM MANAGEMENT

The management of the Seymour Arm electrical system, although it is difficult to quantify, will vary depending on the nature of the alternative selected. The grid connection is the most straightforward, as the management falls under BC Hydro jurisdiction and the community would have no responsibility.

The hydro power and diesel power systems both require involvement by the community to about the same degree. With an independent system, the community would have to organize a utility to set rates, maintain the system and collect payments. A knowledgeable person would have to be hired on a full or part time basis to maintain the equipment. The community would also be responsible, through insurance or their own resources, to repair any part of the system should there be an accident resulting in damage to the generating equipment or distribution system.

8.5 ALLOCATION OF COSTS

One of the more difficult problems facing the Seymour Arm residents is to determine an equitable arrangement for sharing the capital costs of any new system. The main complication is the large proportion of seasonal residences which would not use as much power as permanent residents but which have an equal share in the cost of bringing in the service. They also have the right to use more power or become permanent residents in future. Owners of undeveloped land also benefit from having accessible power and should be expected to share in the costs.

In the analysis charts of Appendix 2 the costs of each power supply system are evaluated and the total costs to the community are compared. In most cases the grid connection is the most attractive on a present value basis for the overall system. It is only for high rates of power inflation, at a moderately high growth rate combined with a relatively low discount rate that the hydro power options are more attractive. This is because of the relatively inflation free nature of hydro power as long as system capacity is not exceeded.

The anomaly that is demonstrated by the tables in Section 7 is that the seasonal residents pay a higher cost for hydro power than they do for diesel power. This is because the assumed usage rate for seasonal residents is insufficient to justify the high capital costs of the hydro power system when the seasonal and permanent property assessments are about the same. A similar situation exists when the grid connection is analysed. If annual usage rates are low, a system in which expenses are dominated by operating costs will be less expensive on an annual basis (but not on marginal cost) than a system in which capital costs are dominant. What is not stated directly, but which is reflected by the high capital costs, is that the grid connection has a large capacity to expand power usage at a low cost while the other systems have lower capacity limits and higher marginal costs. Thus if a seasonal resident resided permanently or sold the property to a permanent resident the grid system could easily accommodate the extra power demand and the only extra cost would be the marginal cost of the power used.

An approach must also be developed for assessing the share payable by commercial properties and the logging camp. These installations would likely have higher usage rates than permanent residents and should be prepared to pay a proportionally higher share of the cost.

8.6 RECOMMENDATIONS

The objective of the Seymour Arm Electrification Study is to provide guidance to the community on the most economical power system for their needs and subsequently determine how it should be financed. At this stage of the program we have the following recommendations:

- the lowest cost system based on the costs to the entire population is the grid connection;

- the characteristics of the system are that the more power that is used, the lower the average cost per kilowatt;

- the residents must weigh the factors of improved service against increased cost and determine what is an acceptable level of expenditure;

- capital costs of any system should be divided among residents in proportion to property assessments because the service connection exists at each residence without restriction on the use of power. The potential exists for more power use at seasonal residences if they are used in the winter and for houses to be built on undeveloped lots. If capital costs are divided on the basis of property tax assessments, summer residents will be charged at slightly lower rates because the cabins may be smaller and may not be winterized, and undeveloped land will be charged at an even lower rate;

- allocations of funding from commercial properties and the logging camp should be based on the ratio of their annual power use compared with the annual power use of the total system permanent residents. This method allows for the expected higher power use in relation to the property assessment at these locations;

- it is presumed that this first stage report will be widely circulated amongst residents, the regional district, BC Hydro and other concerned parties so as to elicit a response. This will allow many of the assumptions in this report to be confirmed in the second stage report;

- after agreement on the alternative for electrical supply, steps must be taken to finalize financial and design arrangements to confirm system costs.

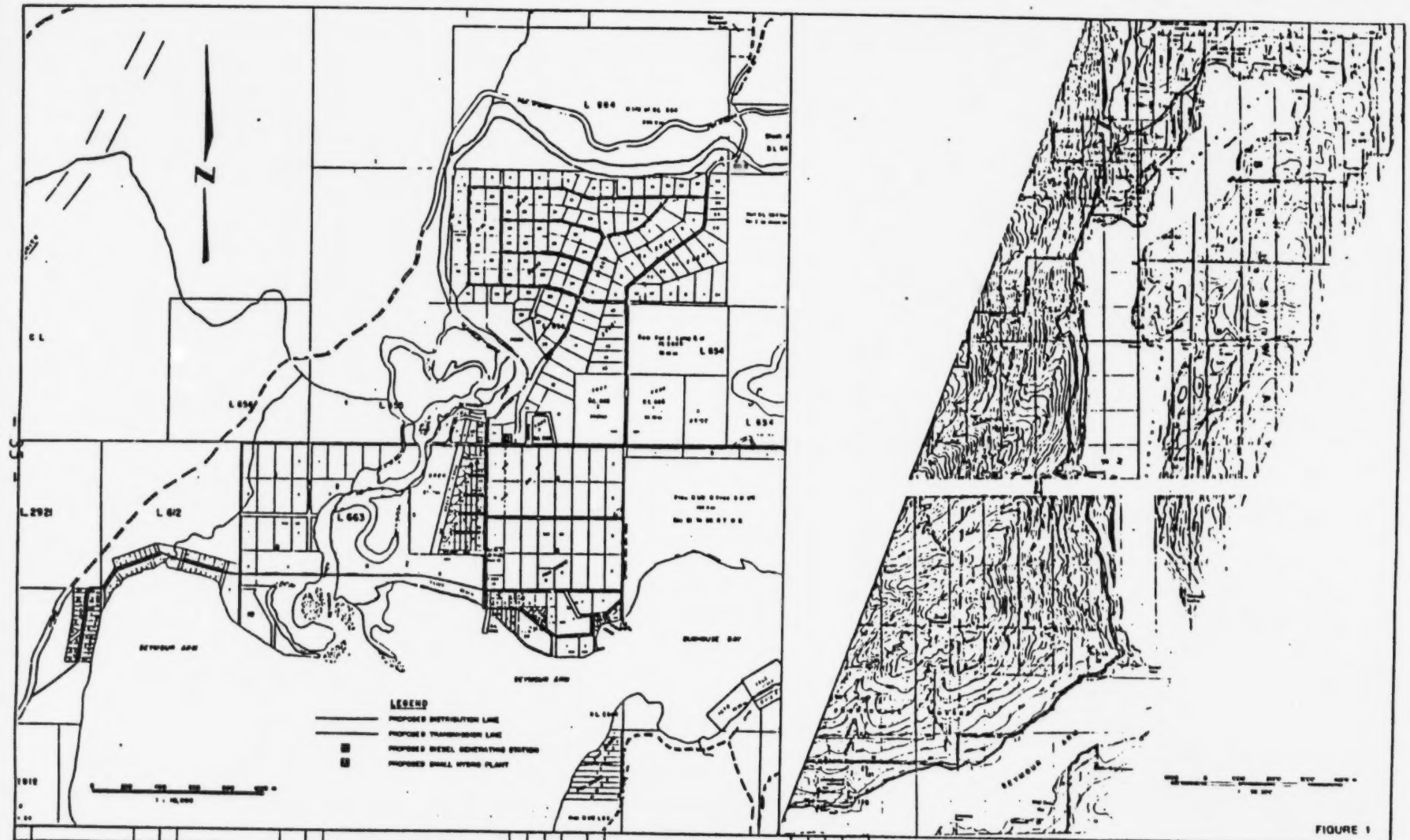
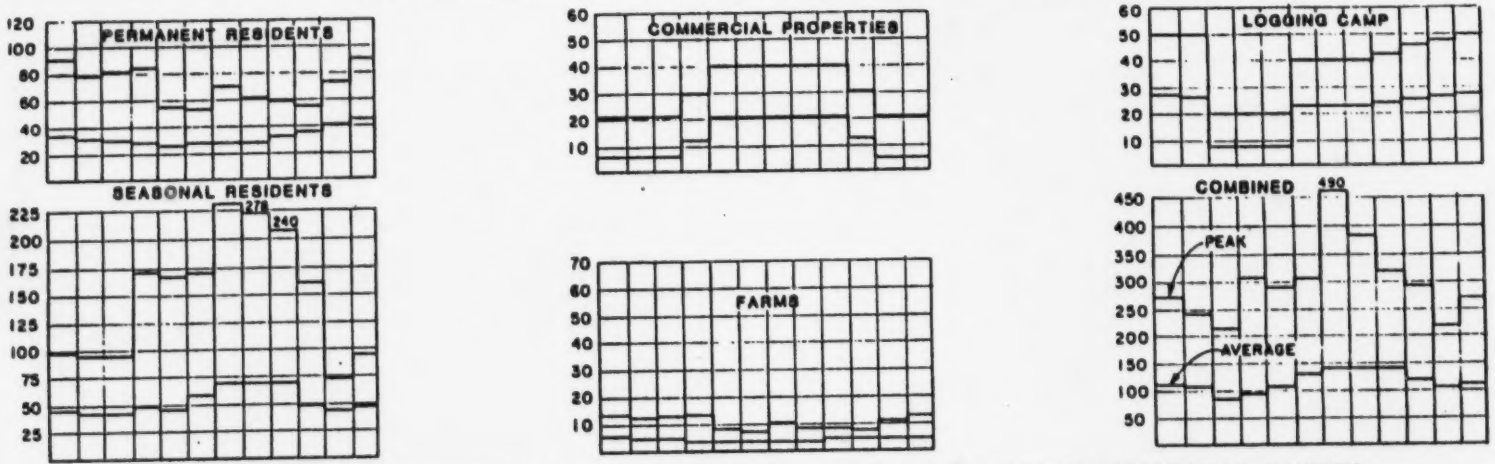


FIGURE 1

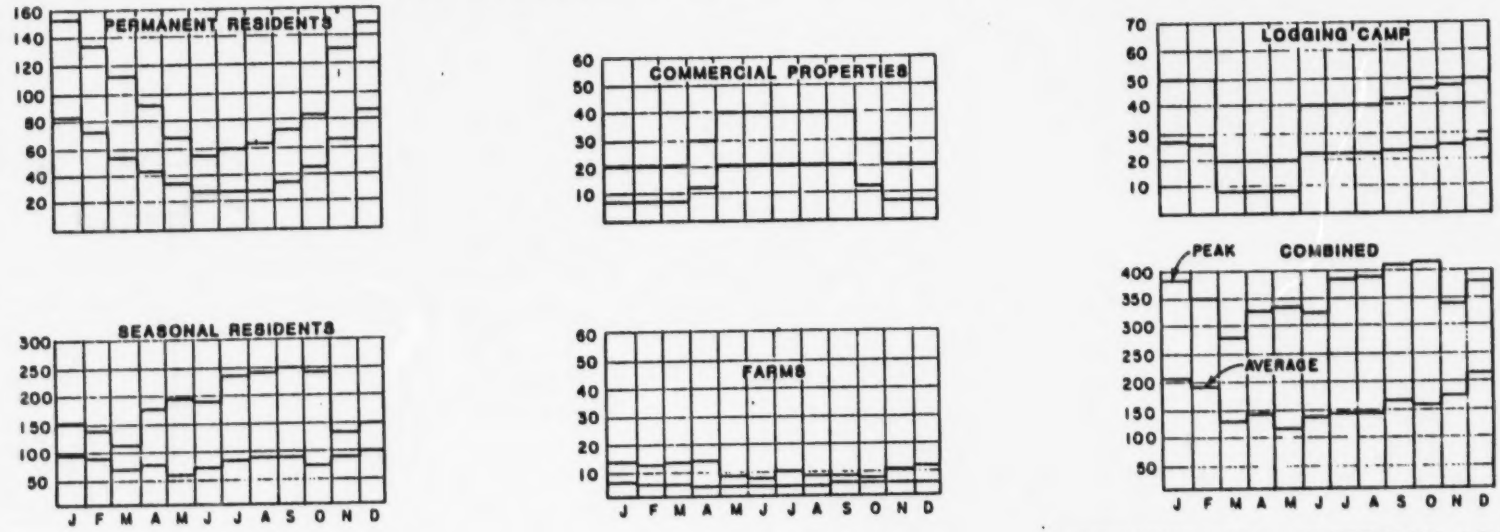
SIGMA ENGINEERING LTD

LOCATION PLAN

AVERAGE MONTHLY LOADS AND PEAKS 1983 - ASSUMING PROVINCIAL AVERAGES

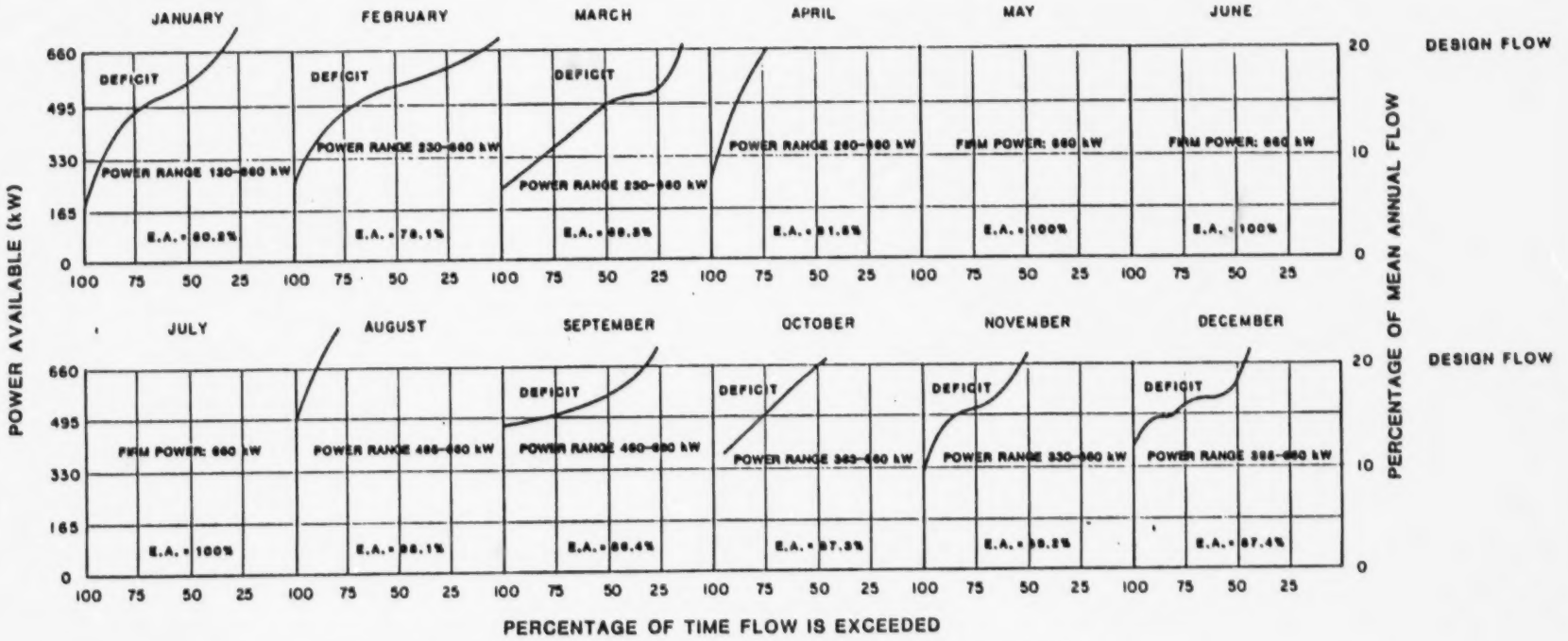


AVERAGE MONTHLY LOADS AND PEAKS 1983 - ASSUMING 50% ELECTRIC SPACE HEAT IN HOMES



SEYMOUR ARM - ELECTRICAL LOAD PATTERNS

FIGURE 2

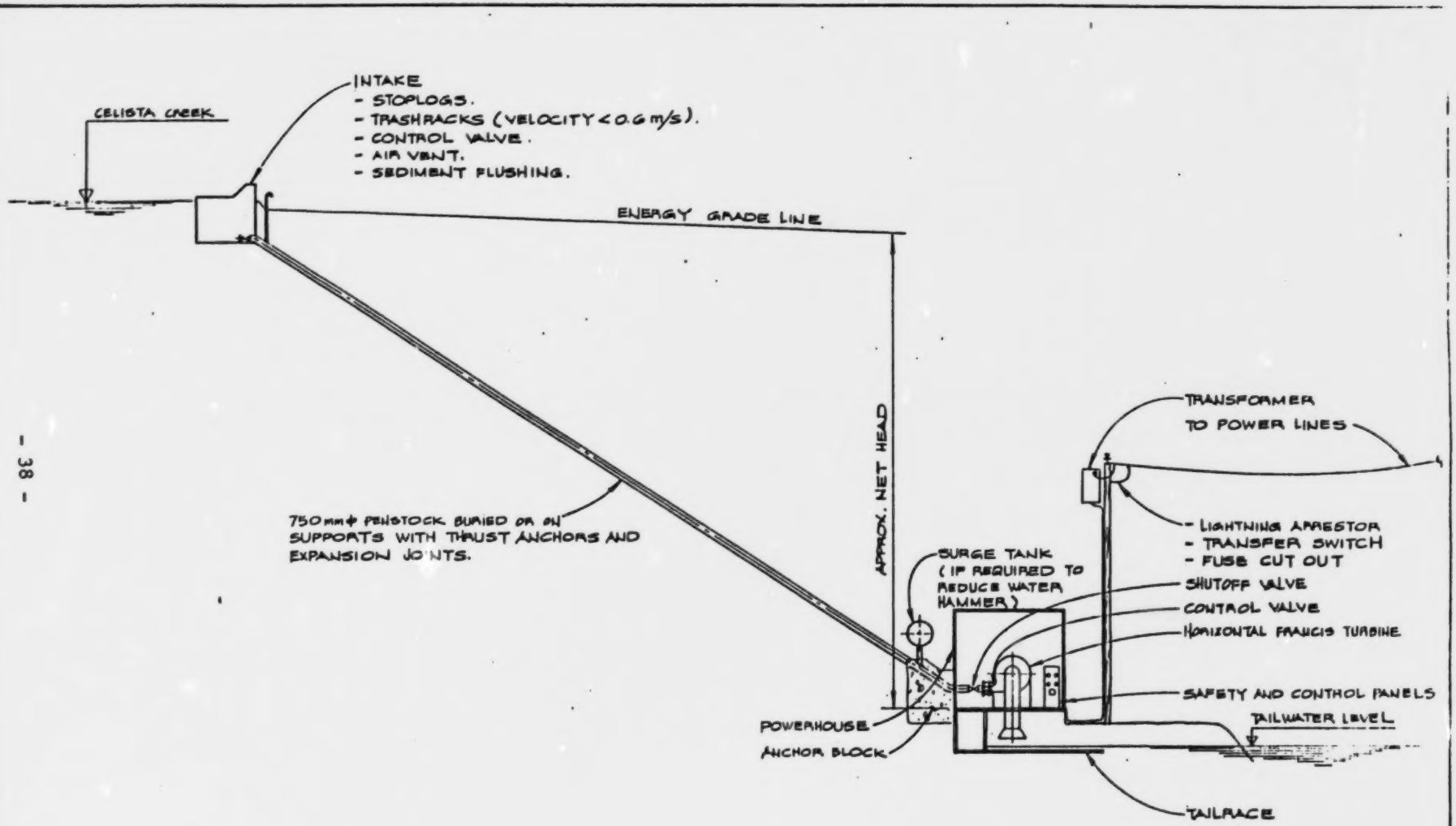


FLOW DURATION CURVES FOR 660 kW PROJECT ON CELISTA CREEK

NOTES:
1. Plant Design Flow 35 cfs (0·99 m^3/s)
2. Stream Mean Annual Flow 177 cfs (5 m^3/s)
3. Annual Power available = 5,140,000 kW.h (88·9% of capacity)
4. E.A. = Energy Availability
5. Deficits in power availability are caused by low stream flows and could occur at any time of the month. The deficits shown are averages (some years higher, some years lower) but the ranges represent the extremes of flow during the period of record.
6. Based on Water Survey Gauge 08LE025, period of record 1914 - 1924

SMALL HYDRO POWER AVAILABILITY

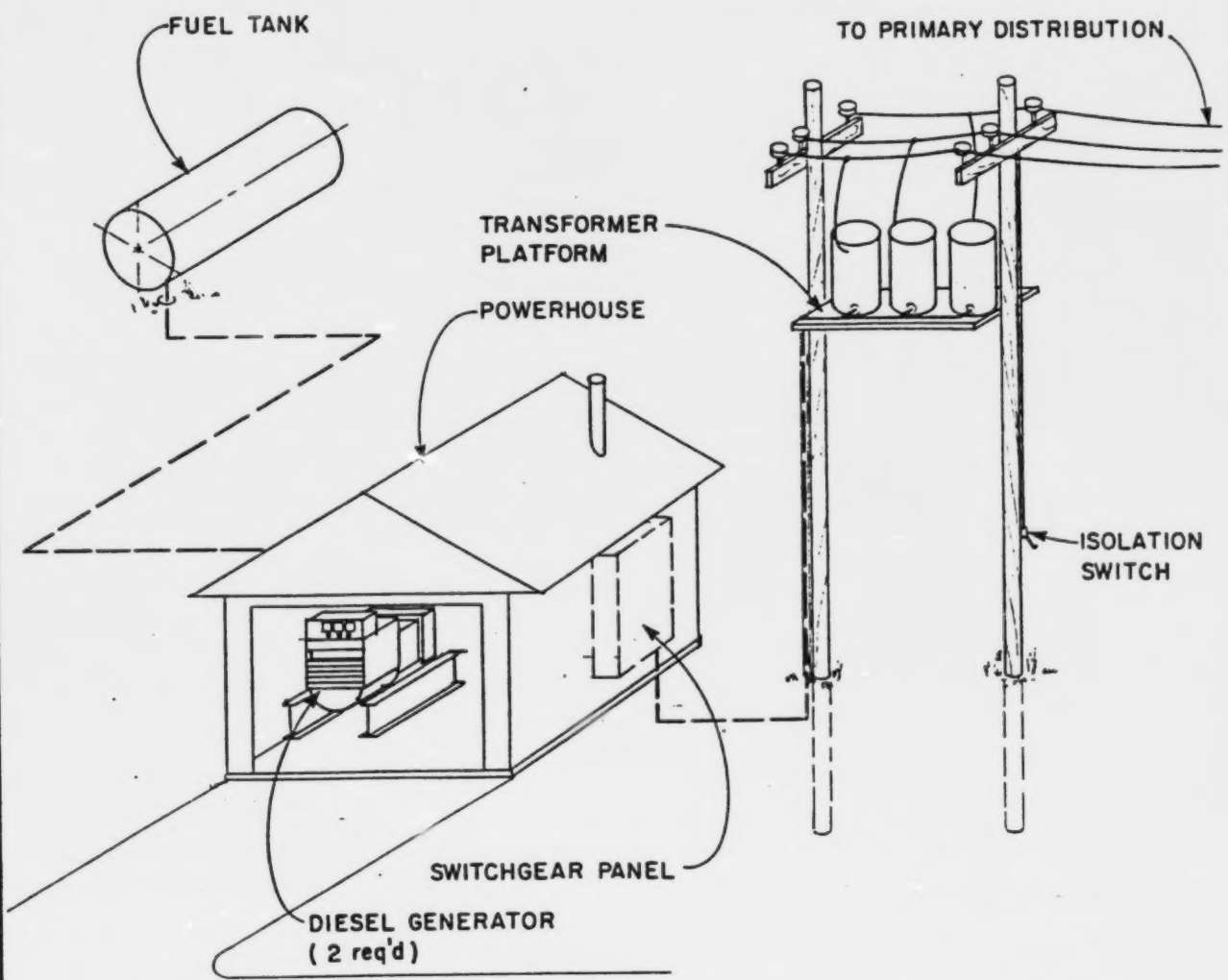
FIGURE 3



SEYMOUR ARM – CELISTA CREEK
SMALL HYDRO POWER SYSTEM DIAGRAM

FIGURE 4

SYSTEM REQUIREMENTS - Accessible for fuel delivery
- Accessible to fire hall
- Low noise level
- Convenient for maintenance



SEYMOUR ARM
DIESEL POWER SYSTEM DIAGRAM

FIGURE 5

APPENDIX 1

Applicability of the electrification program for Seymour Arm to the Remote Community Demonstration Program

1.1 PROGRAM

The Remote Community Demonstration Program (RCDP) is a Federal Government initiative carried out under the sponsorship of Energy, Mines and Resources Canada. In compliance with the National Energy Program, the program has the primary objective of reducing oil consumption in remote communities, which in turn has national implications by reducing oil imports.

The highlights of the program are as follows:

1. The program was established for remote communities not served by the main electric grid and without access to gas which have:

- at least 5 years of planned life remaining;
- at least 10 occupied principal residences;
- no firm commitment from a utility for a gas or grid connection.

2. The program is aimed at reducing dependence on oil, particularly for power and space heating through the use of conservation and alternative local energy sources.

3. Program Outline - Phase 1

   Funding is available for remote communities to investigate alternative energy supply and energy conservation options available to the communities. Applications for such funding can be made by single communities, groups of communities, agencies concerned with energy supply (forestry, mining or fishing companies) or by consultants acting on behalf of the communities.

   About nine studies will be funded in British Columbia through 1983 to early 1984.

4. Funding will be in the range of $10,000 to $25,000, depending on the merits of the proposal. Cost sharing studies may be given preference.

5. Program Outline - Phase 2

   A limited number of practical, effective and economic projects will be funded which will demonstrate conservation and alternative energy techniques which can be widely applied to other communities. These will occur from 1984 to 1989.

1.2 SELECTION CRITERIA FOR PHASE 1 STUDIES

Proposals will be reviewed by a committee of representatives from Energy, Mines and Resources Canada, the B C Ministry of Industry and Small Business Development, the B C Ministry of Energy, Mines and Petroleum Resources, B C Hydro and Indian and Northern Affairs Canada, using a comprehensive evaluation system based on pre-determined criteria.

The criteria will take into account:

- potential for reducing use of petroleum based fuel;
- potential to promote general awareness and local initiative in viable alternative energy and conservation measures;
- potential for wide scale applications;
- potential for socio-economic benefits to the community;
- commitment and capability of the community to implement recommendations;
- sensitivity of the study proponents to community concerns;
- soundness of the proposed work program and schedule;
- technical/management capability of applicant/consultant;
- reasonableness of cost, and the contribution by the community;
- extent of cost sharing by the community.

1.3 BENEFITS OF THE STUDY TO SEYMOUR ARM

The Study has the two principal objectives of evaluating the power supply options for the community and evaluating the financial mechanisms for implementing the optimal scheme. Although some previous investigation was done by the community for the three power system options (grid connection, hydro power and diesel) some further analysis was required to put the systems on a comparable basis. This meant that normal amounts of power (based on provincial averages) would be available to all customers, there would be provision for expansion and that initial capital and annual operating costs would be calculated.

Financial costs are also evaluated and these require both a technical input and an input from the community. Assuming that any power scheme will result in residual capital costs which must be community funded, part of the purpose of the study is to present the many ways in which the community could meet the costs. In considering that the total cost is fixed and that only the division of cost must be decided, sectors of the community (or categories of land ownership and use) may face different costs. There may be disagreement on which methods are the most equitable, if not the least expensive for any particular sector. Some of these options are presented with the idea of stimulating community discussion which is expected to result in a solution which best matches the benefits and costs to the community. Agreement by a majority of the community is essential to the implementation of a power supply scheme.

Another consideration involved with the study of financial options is that various agencies will be responsible for parts of the financial process. These will be listed to provide a starting point for future negotiations. Once the community agrees on an acceptable internal financial method, the course of action to initiate the construction of a power system will be clear.

1.4 BENEFITS OF THE STUDY TO THE REMOTE COMMUNITY DEMONSTRATION PROGRAM

The immediate purpose of the Seymour Arm Electrification Study is to provide the community with the mechanisms to achieve a cost effective power supply system. This will provide the citizens with an improved standard of living and a lower average cost for power.

There are also potential benefits to the Remote Community Demonstration Program, both tangible and intangible. The most obvious benefit if Seymour Arm proceeds with a power supply system is that the dependence of the community on oil will be reduced and the national need for imported oil will be reduced accordingly. However, of possible greater significance is the structure of the study and its applicability to other remote communities.

The role of the study as a demonstration project is shown in a number of ways. At first, the mechanism to allow a study to proceed must be developed. The community must have an organization which can sponsor the work and administrate the study. At Seymour Arm, the cooperation of the property owners, resident ratepayers and the regional district was demonstrated to initiate the project.

Within the study itself mechanisms are demonstrated which would apply to other communities. Similar studies which compare options and allow feasibilities to be determined should always precede the construction of a major energy project. The techniques used for comparing different systems demonstrate methods for accounting for total system costs and for comparing different ratios of capital to operating costs. The financial mechanisms would also be relevant to other communities in terms of evaluating funding options and of apportioning annual charges to diverse groups of property owners.

The ability of the community to eventually obtain an adequate and economical power supply will be an example of the efforts required on all levels to bring a project to completion.

APPENDIX 2

Present value cost analysis

2.1 INTRODUCTION

A present value cost analysis has been carried out to account for the variables inherent with each power supply scheme under study and translate differing long term costs into a comparable single cost. This effectively brings each power supply scheme onto a common footing to simplify the task of determining the best system for Seymour Arm. A graphical presentation of the analysis is shown at the end of this section.

The options and their relative cost distributions are as follows:

1. Grid Connection: Moderately high initial cost, offset by a sizeable Rural Electrification Assistance grant. Long term costs include the standard province wide electricity mill rate charges.

2. Hydro Power System Type 'A': High initial cost for a 1400 kW hydro power system complete with diesel backup. Low operating costs as long as the capacity of the hydro system is not exceeded but sharply higher operating costs if high community growth rates lead to increasing use of the diesel backup. This option is shown mainly for comparison with the more attractive type 'B' below.

3. Hydro Power System Type 'B': Moderately high initial cost for a 650 kW hydro system complete with diesel backup. Low operating costs until load growth results in more frequent use of the diesel backup.

4. Diesel Power System: Low capital cost for the initial 300 kW system, which can be easily expanded by adding more units. High operating costs for fuel and maintenance and a total dependency on the uncertainties of future oil costs.

2.2 COST COMPONENTS

Each power supply system for Seymour Arm has several cost components which are all shown in order to ensure that the systems will provide a similar level of service. These include:

Capital Costs

- power generation capital costs (these are not appropriate for the grid connection);
- transmission line costs;
- electrical switching and transformation;
- distribution line costs within Seymour Arm;
- backup power system (where required);
- connection charges.

Operating Costs

- maintenance costs;
- fuel costs;
- REA Connection Charges ($10/month for 60 months);
- flat rate connection charge;
- taxes where applicable;
- bi-monthly charges for grid electricity use.

There are infinitely many combinations of individual load requirements, so for ease of comparison, the examples have been based on provincial residential averages, which allows individuals to adjust the costs to their own circumstances. However, the overall costs to the community are the main basis for evaluation which the analysis considers.

2.3 ANALYSIS PARAMETERS

There are many variables in the present value analysis of power supply options at Seymour Arm, and the Figures at the end of this section represent a range of possibilities. The significance of each variable shown on the figures is discussed below.

Power Growth Rate: The power growth rate is a measure of the rate of increase in the annual kilowatt-hours of power used by the entire community. Based on community estimates we would expect a rapid initial growth rate, which would decline to near the provincial average growth rate as predicted by B C Hydro. The most recent B C Hydro provincial forecast shows a range of power growth from 1.9% per year to 4.6% per year over 20 years with a most probable growth rate of 3.4%.

Time Horizon: The time horizon has been fixed as 40 years to be representative of the long life of both a small hydro and a grid connection project.

Discount Rate: The discount rate is representative of the cost of capital. The rate may be treated as either "inflation free", in which case it represents the cost of borrowing less the rate of inflation or it may be taken as the actual cost of borrowing. In the analysis this latter approach is used because inflation rates are also accounted for in forecasting future costs and revenues.

Inflation Rate of Maintenance: It is assumed that maintenance costs in the system (operators wages, spare parts etc) will rise at the general rate of inflation, hence this index represents the general rate of inflation over the time horizon.

Inflation Rate of Power: In recent years the cost of oil and to some extent the cost of natural gas and electricity have increased at a rate at least equal to the general rate of inflation. Using various combinations of the attached charts a range of different inflation possibilities can be examined.

Present Value of Total Costs: The present value is a single cost figure in year 1 which is equivalent to the cost of all of the electrical services used over the ensuing 40 years at the stated rates. The estimated power use in year 1 was based on a combination of community data and provincial averages of power use. In each succeeding year, the total power use was assumed to increase at a compounded annual power growth rate, while the unit costs of the power and maintenance were assumed to increase at the appropriate inflation rates. Each year's cost was converted to an equivalent year 1 cost using the discount rate applied over the number of years since year 1. The summation of the 40 annual present values gives the present value of total operating costs. The capital costs (all incurred in year 1) were added to the operating costs to give the present value of total costs.

2.4 RESULTS OF PRESENT VALUE COST ANALYSIS

The results of the analysis are shown on the figures at the end of this section. Close inspection of the figures and relating the present value to the parameters reveals the following general relationships.

1. The growth rate of power use has more of an impact on the cost of diesel power than hydro power because its costs at high growth rates are dominated by fuel costs. The inflation free nature of hydro power is demonstrated by the steady present values at low power use growth rates. However, high growth rates require supplementary diesel power and costs rise more rapidly.

2. The analysis was carried out for discount rates ranging from 7% to 13%. Lower discount rates increase the present value of long term operating and maintenance costs but have no effect on the present value of capital cost since it is incurred only in the first year.

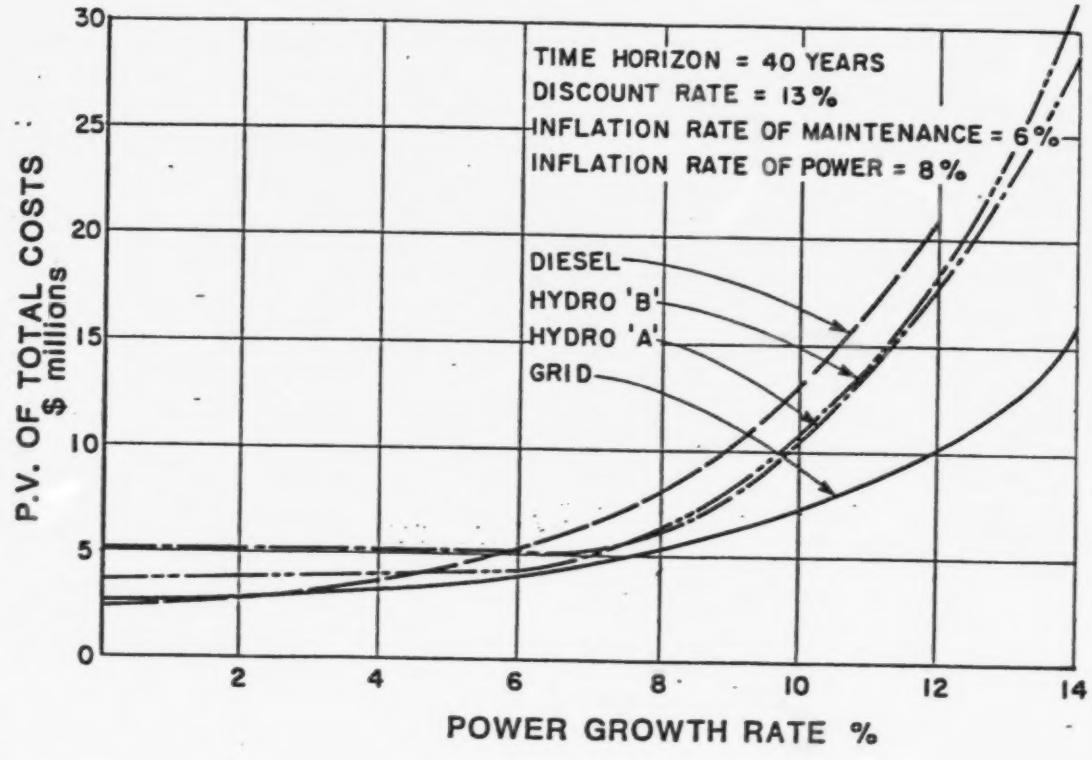
3. The assumed inflation rate affects the forecasted level of future costs and revenues; the higher the inflation the higher the present value of future cash flows. However, if the discount rate is close to the inflation rate, future benefits and costs are affected very little by discounting. This tends to favour capital cost intensive systems (ie make diesel look the most unattractive). In the extreme case where the discount rate is lower than the inflation rate of power the hydro system is favoured through the range in which diesel backup is not needed. Diesel power is only attractive for low inflation rates and low growth rates. Note, however, that the discount rate and the inflation rate are linked by general economic forces so that they tend to move in the same direction. The discount rate should usually be set above the inflation rate by a margin which depends on the type of project.

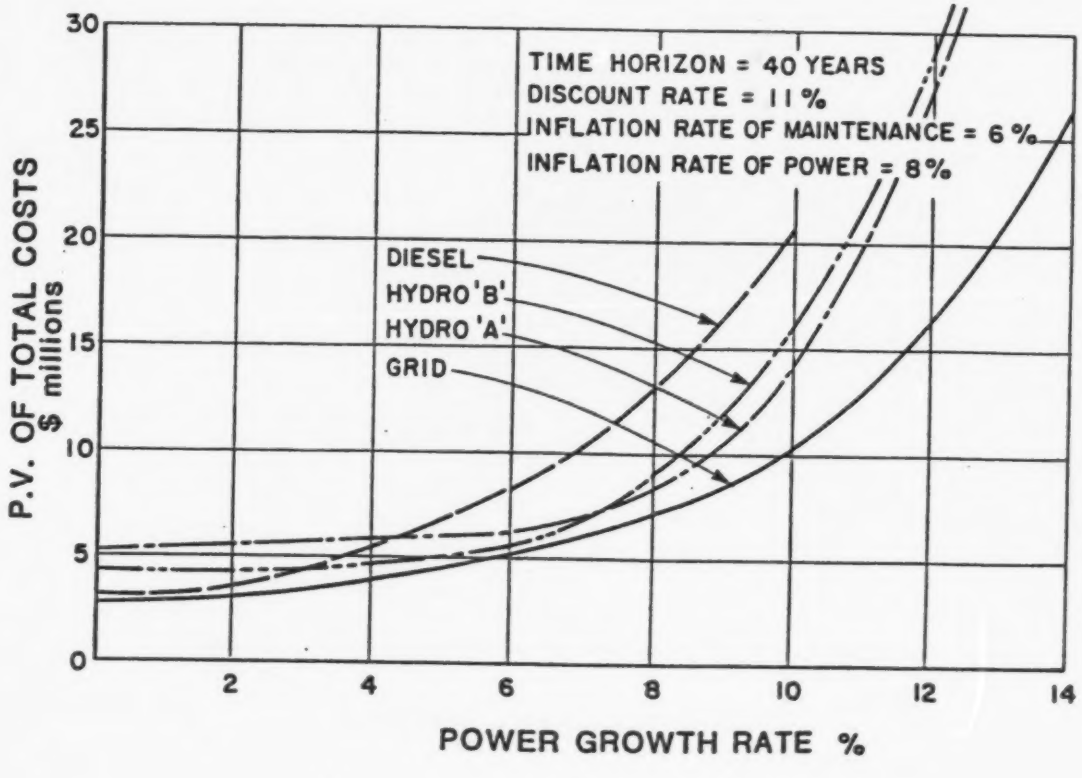
4. The most probable values for the Seymour Arm system are a power use growth rate of 2 - 6%, an inflation rate of maintenance at 6%, an inflation rate of power of 6 - 8% and a discount rate of 9 - 13%. Under these conditions the grid system is always favoured. The grid system is also favoured at the highest growth rates, indicating that it has the lowest cost of expansion and a low marginal cost at high usage rates.

2.5 CONSUMER COST OF POWER

Using the most probable growth and inflation figures, the consumer cost of power is shown on Figure A2-7 for the various power supply systems. The key assumption is that the capital costs of the system are divided amongst all property owners, in accordance with the cost share scheme proposed in Appendix 3. Individuals would then pay for power used at the prevailing rates. It is also assumed that growth in power demand is accompanied by growth in the community improvement tax assessment base (the supply of land is fixed), thereby reducing the individual's share of capital costs with time.

The results are based on the 3 categories of land ownership paying for capital costs at the same ratio while paying operating costs based on the number of kilowatt hours used. The tables of Section 7 are used as a base, although Figure A2-7 accounts for inflation. The Figure indicates that for users of power, the grid system is the most economical, while for non-users of power (owners of undeveloped land) the diesel system is the least expensive because of its low, capital cost. However, if the land was developed within 5 years for example, the first year's savings with a grid connection would approximate the accumulated differential payment.


TIME HORIZON = 40 YEARS
DISCOUNT RATE = 13%
INFLATION RATE OF MAINTENANCE = 6%
INFLATION RATE OF POWER = 8%
DIESEL
HYDRO 'B'
HYDRO 'A'
GRID
P.V. OF TOTAL COSTS
$ millions
POWER GROWTH RATE %
0
5
10
15
20
25
30
2
4
6
8
10
12
14


TIME HORIZON = 40 YEARS
DISCOUNT RATE = 11%
INFLATION RATE OF MAINTENANCE = 6%
INFLATION RATE OF POWER = 8%
DIESEL
HYDRO 'B'
HYDRO 'A'
GRID
P.V. OF TOTAL COSTS
$ millions
POWER GROWTH RATE %
0
5
10
15
20
25
30
2
4
6
8
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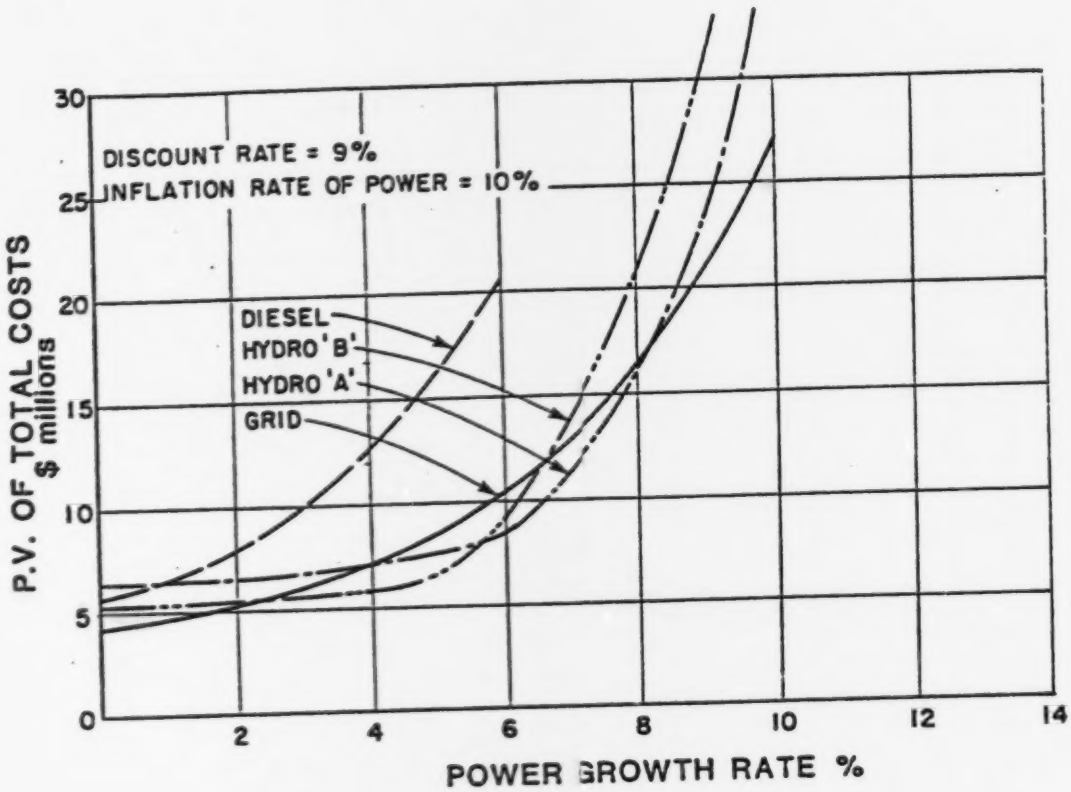
12
14

FIGURE A2-1



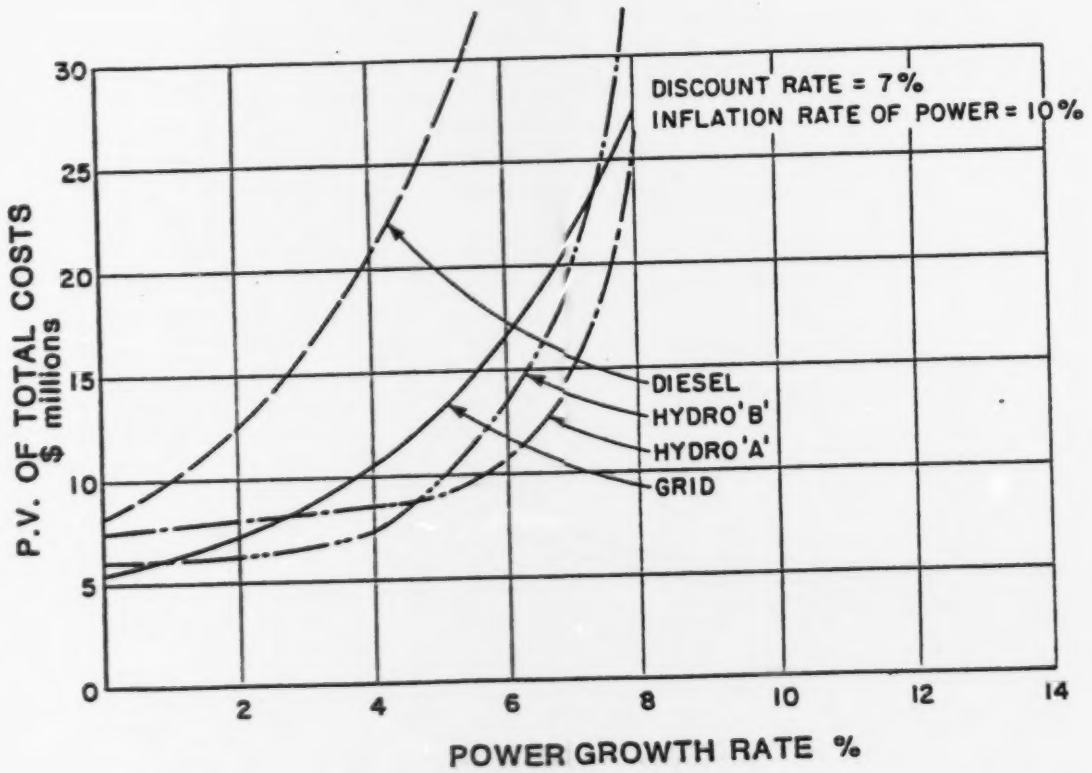


FIGURE A2-2

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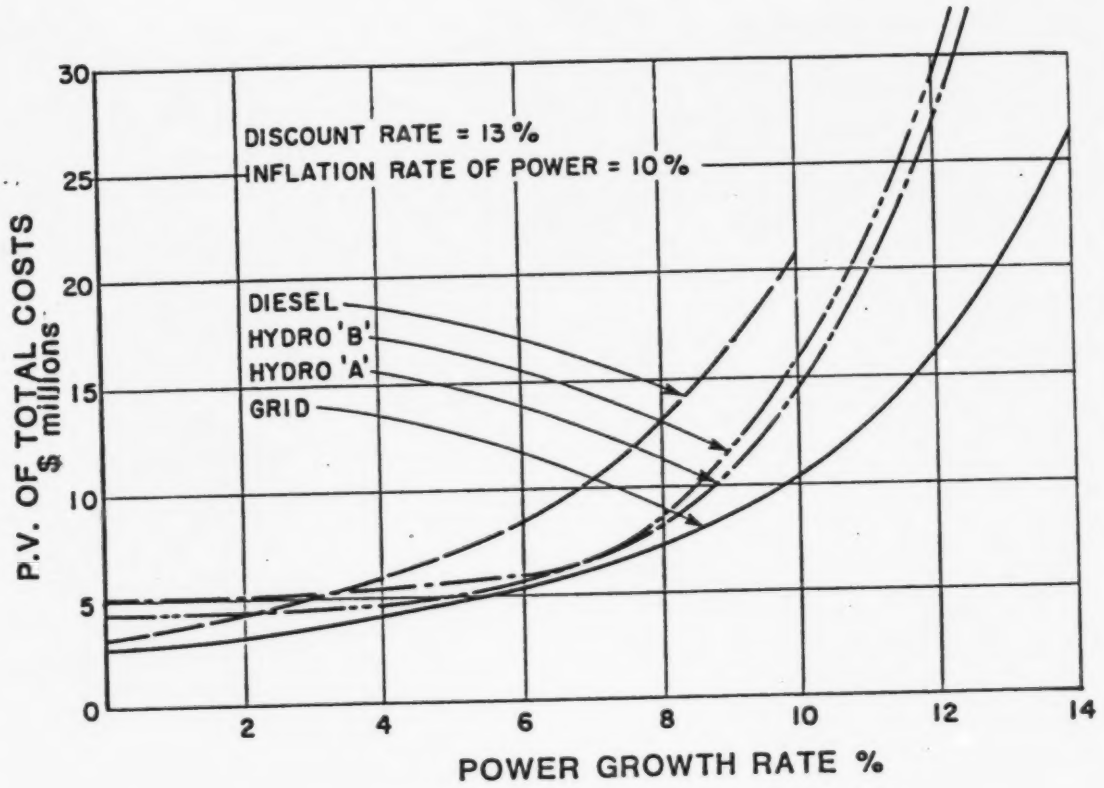
DISCOUNT RATE = 13 %
INFLATION RATE OF POWER = 10 %
DIESEL
HYDRO 'B'
HYDRO 'A'
GRID
P.V. OF TOTAL COSTS $ millions
POWER GROWTH RATE %
0
5
10
15
20
25
30
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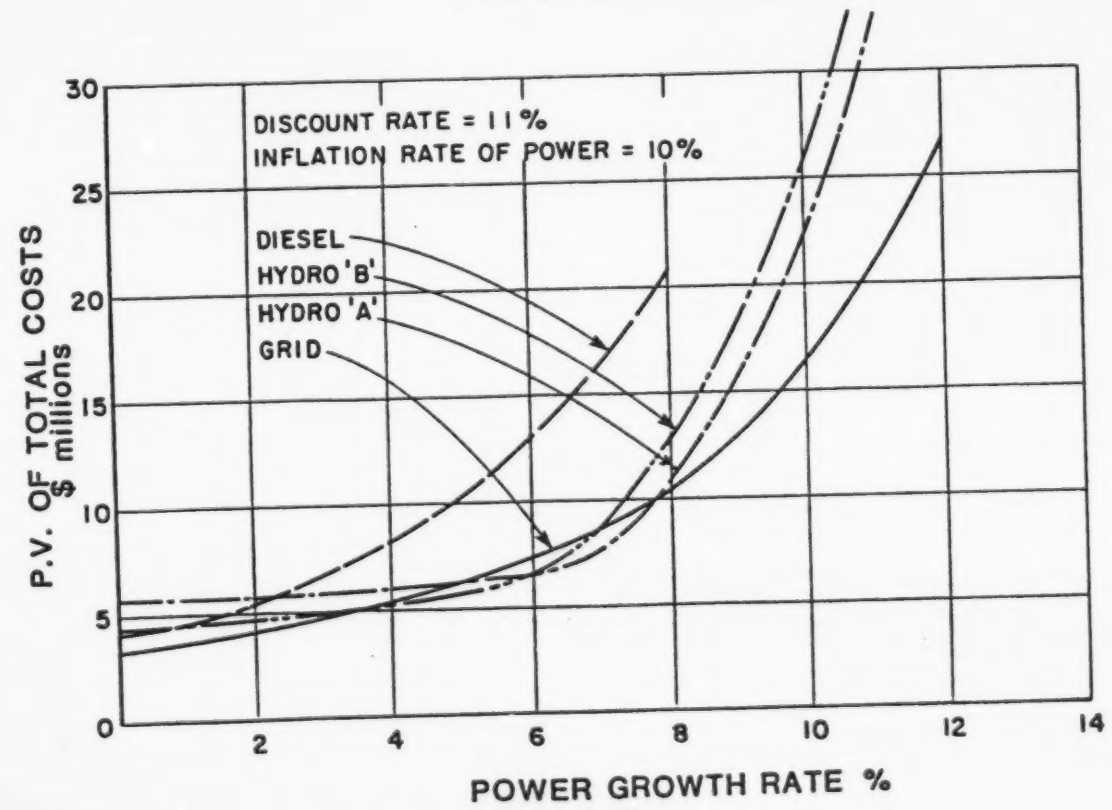
12
14


DISCOUNT RATE = 11 %
INFLATION RATE OF POWER = 10%
DIESEL
HYDRO 'B'
HYDRO 'A'
GRID
P.V. OF TOTAL COSTS $ millions
POWER GROWTH RATE %
0
5
10
15
20
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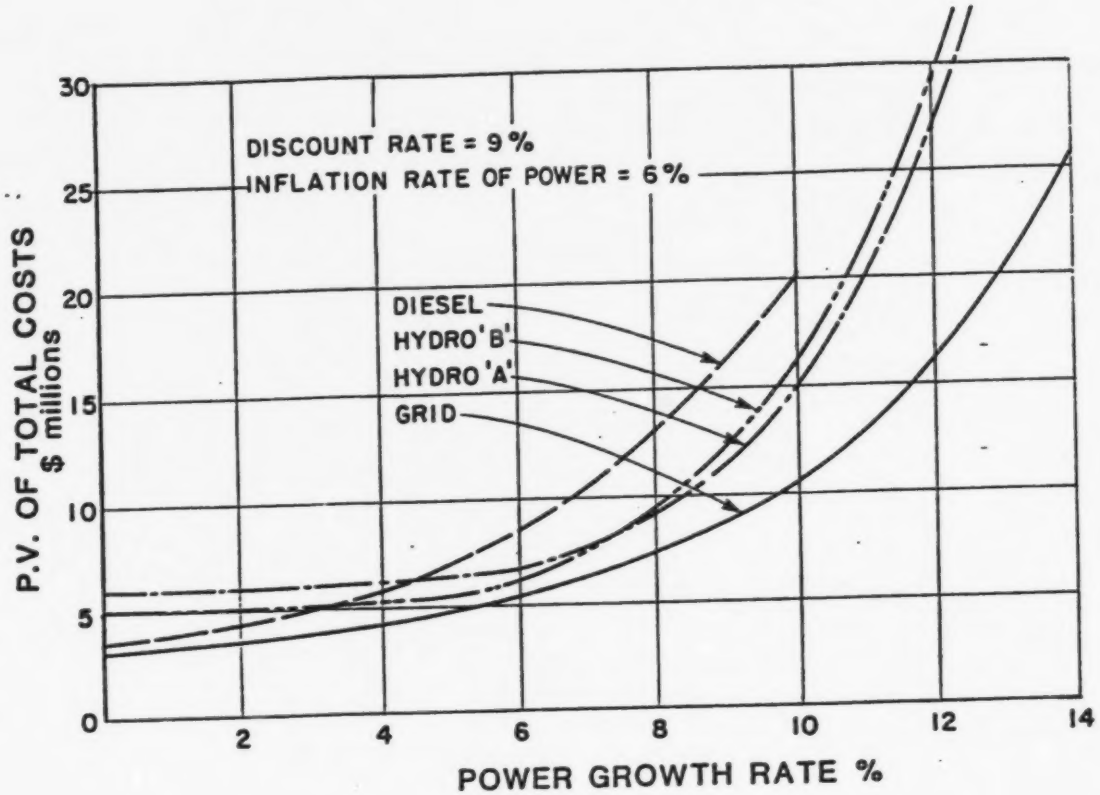
10
12
14

FIGURE A2-3



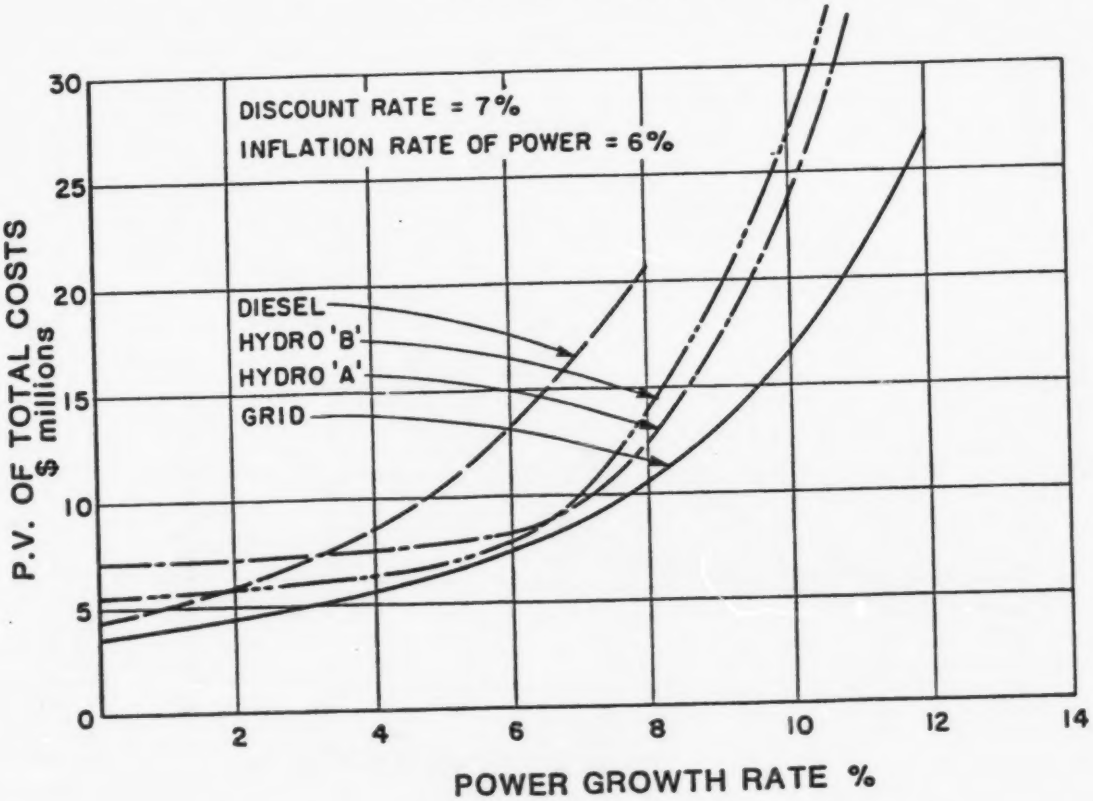


FIGURE A2-4

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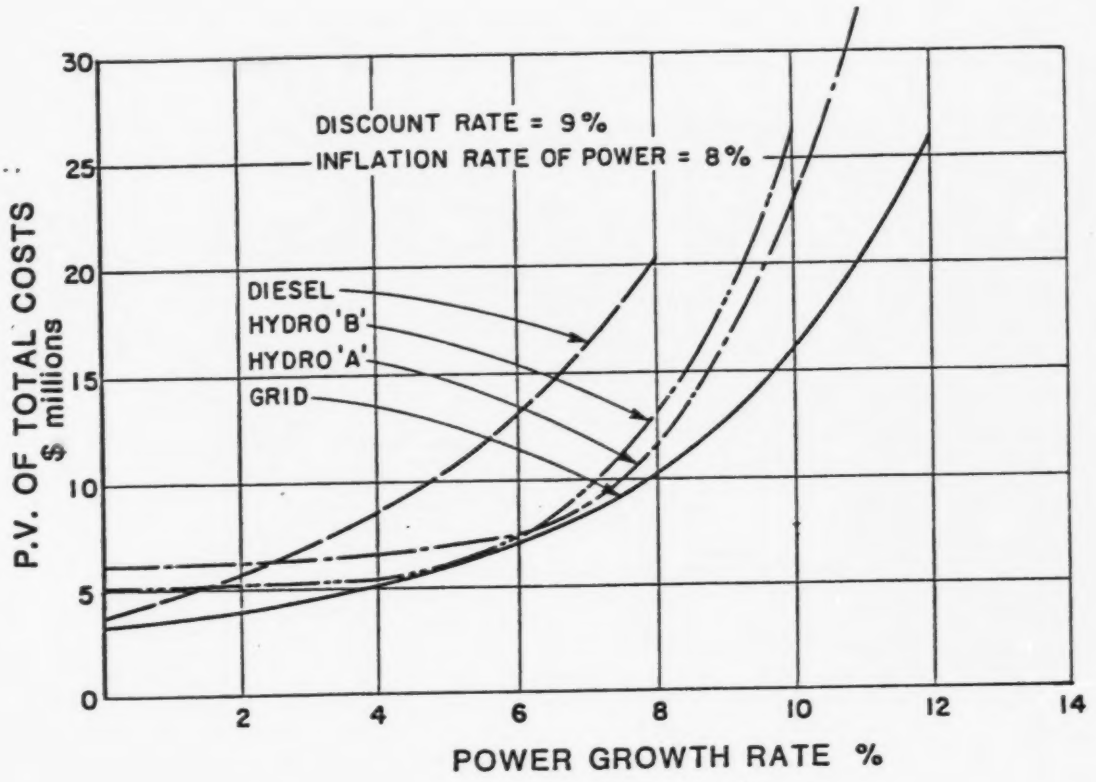


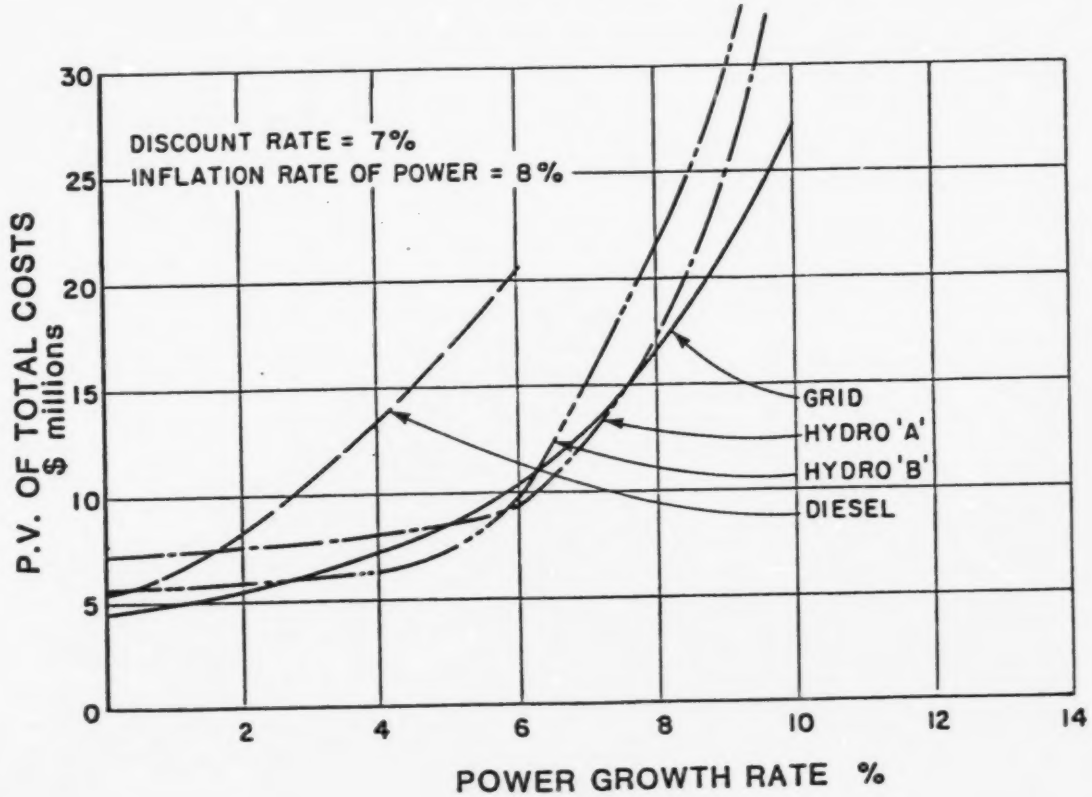
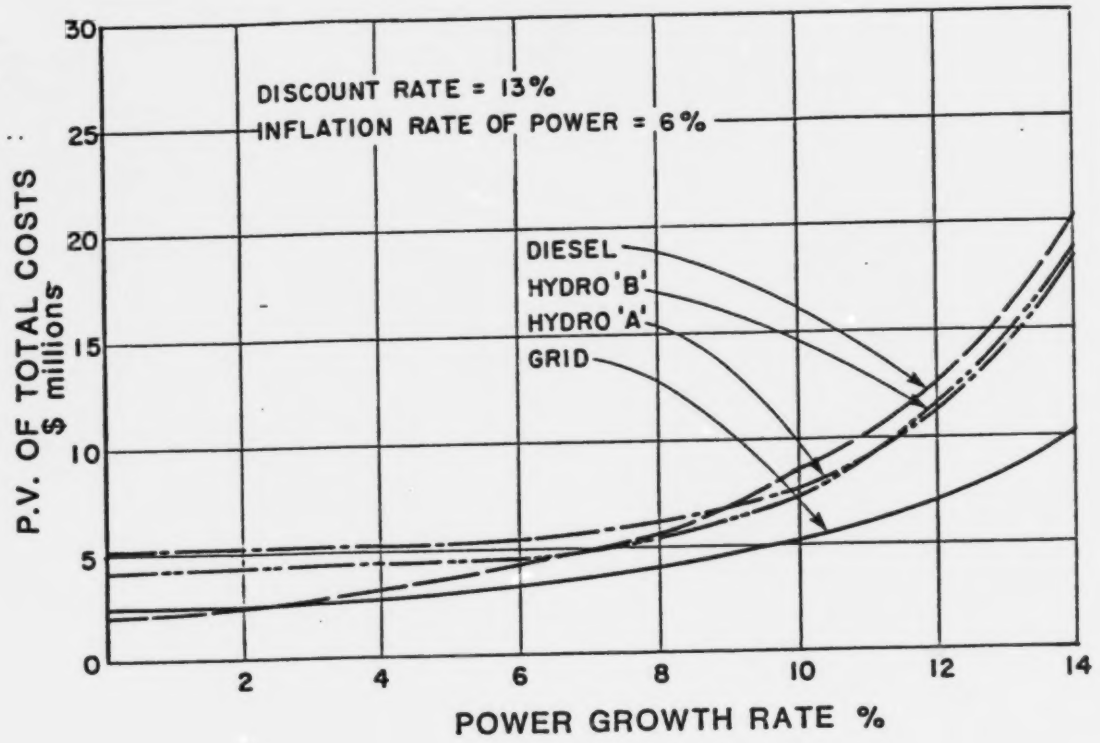


FIGURE A2-5

5506


DISCOUNT RATE = 13%
INFLATION RATE OF POWER = 6%
DIESEL
HYDRO 'B'
HYDRO 'A'
GRID
P.V. OF TOTAL COSTS
$ millions
POWER GROWTH RATE %
0
5
10
15
20
25
30
2
4
6
8
10
12
14

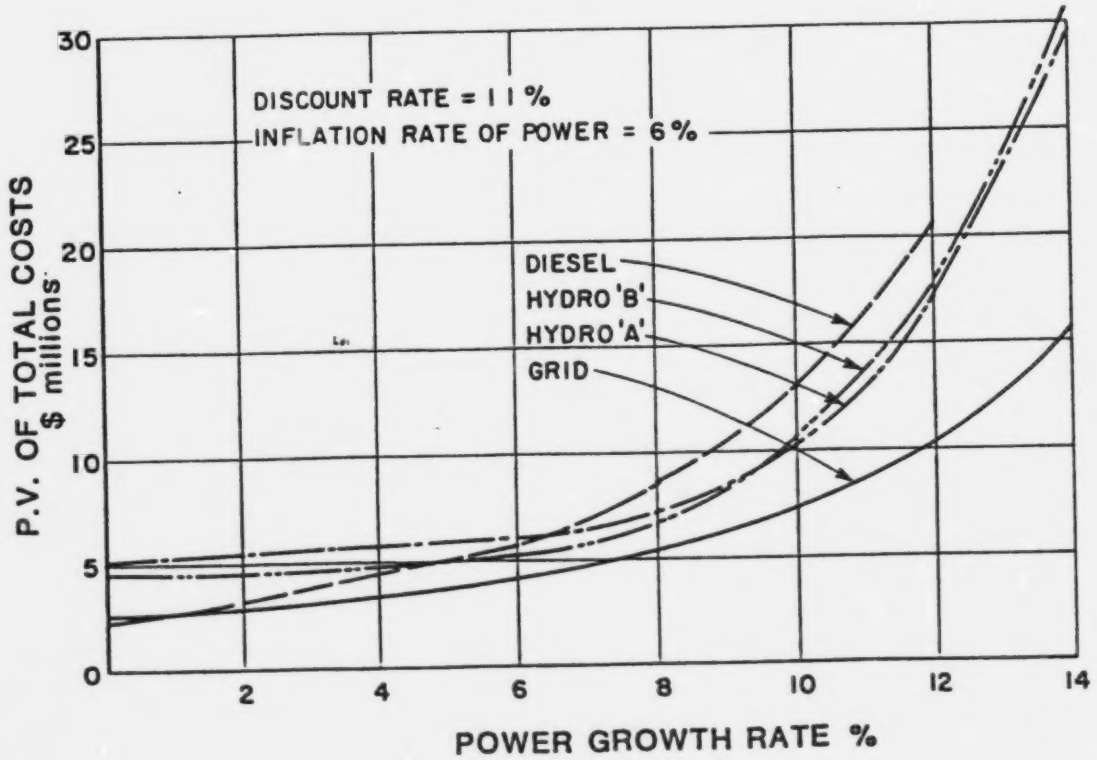
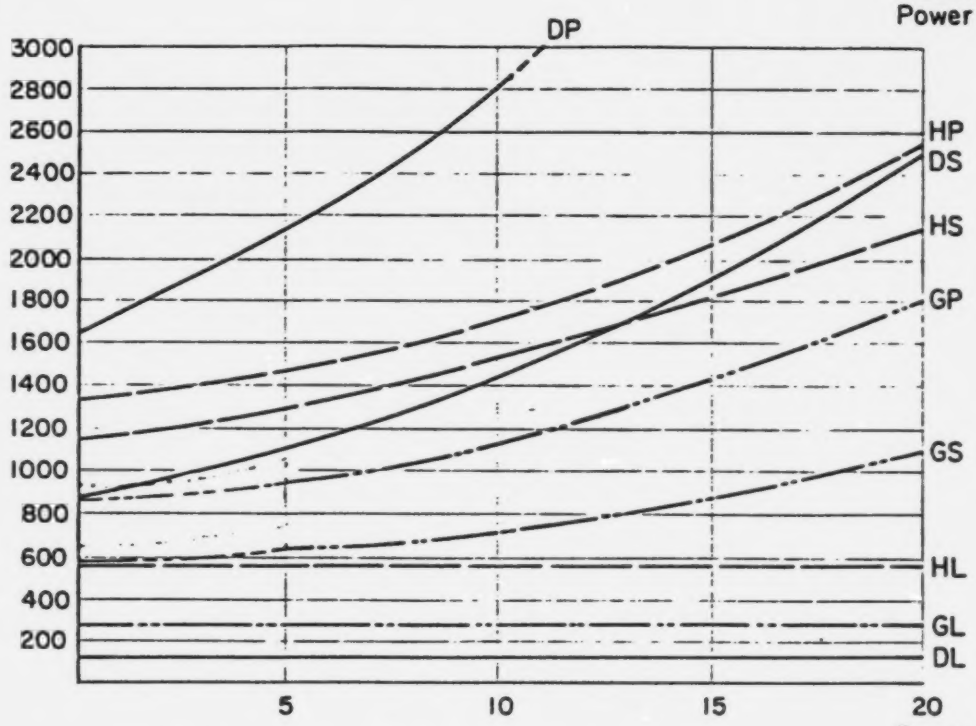
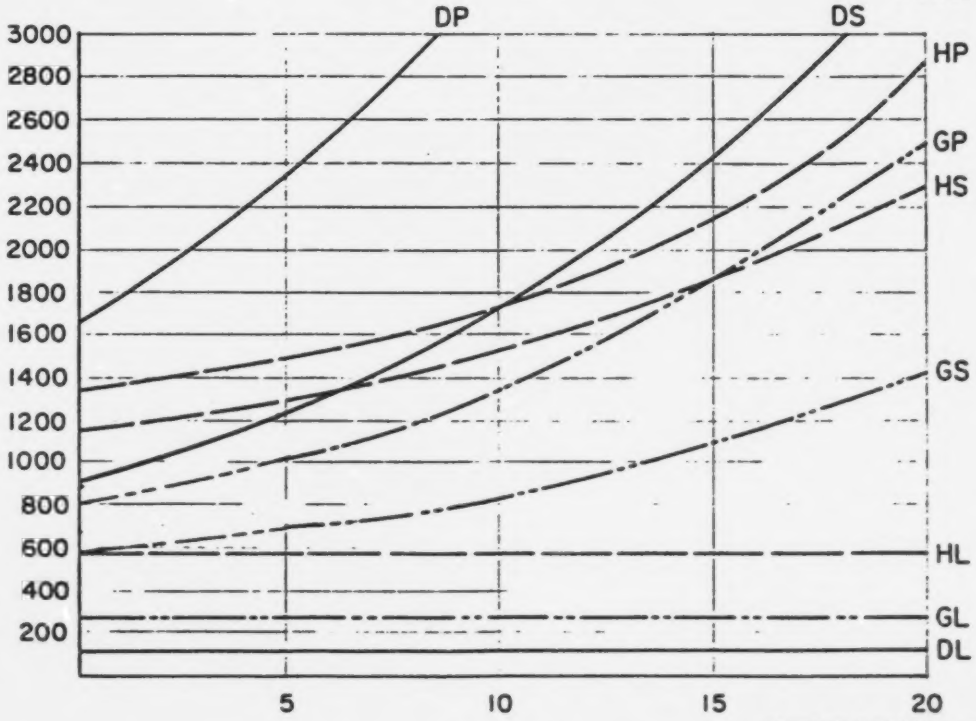

DISCOUNT RATE = 11%
INFLATION RATE OF POWER = 6%
DIESEL
HYDRO 'B'
HYDRO 'A'
GRID
P.V. OF TOTAL COSTS
$ millions
POWER GROWTH RATE %
0
5
10
15
20
25
30
2
4
6
8
10
12
14

FIGURE A2-6





SEYMOUR ARM
ANNUAL CONSUMER COST OF POWER

FIGURE A2-7

APPENDIX 3

Preliminary proposal for financing electrification scheme

3.1 INTRODUCTION

Any of the electrification schemes for Seymour Arm involves a component of capital cost which must be met by the community. There are many ways of apportioning the cost and it is the objective of this section to present some alternatives for future discussion by the community. Annual operating costs are more easily handled by using a combination of flat rate connection charges and power consumption charges based on meter readings, just as B C Hydro customers are charged.

3.2 DETERMINATION OF RESIDUAL COSTS

The residual costs of the electrification schemes are determined by adding all of the capital costs of each scheme and subtracting the applicable grants and subsidies. The balance must be paid by the community.

In order to make the cost as affordable as possible efforts must be made to mnimize the community share. This can be done by minimizing construction costs and maximizing the grants and subsidies. Construction costs can be minimized by building a system that is the right size for the community, by doing some portions of the work within the community (such as clearing) and by ensuring that competitive bids are obtained for specialized work.

The grants and subsidies can be maximized in a number of ways, however the most feasible way is to obtain more grants from different sources. The financial assistance will vary depending on the electrification system constructed. The applicability of some of these programs is detailed in Table A3-1. It should be noted that most programs involve complex qualification procedures and that there are few guaranteed grants with the exception of the REA grant.

3.3 APPORTIONING THE RESIDUAL COSTS

Once the community share of the residual costs is determined, that cost must still be divided equitably amongst the residents, commercial properties, farms and the logging camp. Not only must the cost be equitable, but it must be seen to be comparable to other forms of electrical generation.

There are many forms of cost apportioning and the difficulty arises in that perhaps none of them are completely fair to all property owners. With so many diverse groups in the community there have to be decisions made regarding the degree of benefit received by each group and then the cost share determined. Eventually the community will have to agree to the plan proposed. A proposal which attempts to recognize disparities amongst groups and which also recognizes the benefits to the entire community is shown below.

TABLE A3-1

GRANTS AND SUBSIDIES APPLICABLE TO SEYMOUR ARM ELECTRIFICATION

Grant	Criteria	Limitation	Approx Value
REA (B C Hydro)	$11,000 per permanent resident $400 per seasonal resident $11,000 or 4 x revenues for commercial	Grid only	$ 425,000
Pole Cost Share (B C Tel)	40% of cost of pole in place where telephone lines share	Distribution poles only	$ 40,000
RCDP (Energy, Mines and Resources)	- Permanent community - 10 residences - no commitment for grid or gas connection	Phase 2 Program not finalized. Would only apply to unique and and demonstratable projects (Probably not grid, possibly small hydro)	Varies
Employment Development Branch (Employment and Immigration)	Programs exist for local projects	Application to be made through Kelowna Regional Office once study finalized	
ARDA (Provincial Department of Agriculture)	Some assistance may be available to farmers only	Program not finalized	

Proposed Cost Share Arrangement

Principles

1. All properties will benefit by having power available at Seymour Arm.

2. In general there should be a charge based on anticpated power use of the property (even undeveloped properties could eventually become power users).

3. The difficulty with (2) above is that future power use is uncertain, especially when the development pattern could change.

Proposals

1. Total estimated power use in the area is 1,012,500 kW.h the first year of a grid connection. The logging camp's power use would be 180,000 kW.h, therefore the logging camp should pay 17½% of the system residual cost. In addition they would pay the meter charge for power use.

2. The community itself is made up of approximately 400 properties, all of which would be within a relatively short distance of the distribution system. In addition 27 properties have full time residences, 111 properties have seasonal residences, while the remaining developed properties have 7 commercial establishments and 2 farms. Recognising that these properties will use different amounts of power, it is proposed that a combination of property values and assessment values be used to determine the equitable share.

3. The cost share is based on

- minimum lot price of	$15,000	
- seasonal residence valued at	$30,000	(building only)
- permanent residence valued at	$45,000	(building only)
- farm valued at	$90,000	(building only)
- commercial establishment valued at	$60,000	(building only)
Assessment multiplier	100% 10%	land improvements

Note that the above values are hypothetical, used for the purpose of generating an example.

Total Assessment

400 lots @	$15,000	$ 6,000,000
111 seasonals @	$30,000 x .1	333,000
27 permanents @	$45,000 x .1	121,000
7 commercial @	$60,000 x .1	42,000
2 farms @	$90,000 x .1	18,000
		$ 6,514,000

4. As an example of the cost for each sector of the community (refer also to Table 7.1 etc) consider a grid connection.

Installed Cost		$ 1,565,866
REA Grant	Permanent	(297,000)
	Seasonal	(44,400)
	Commercial	(77,000)
	Farms	(31,600)
	Logging Camp	(32,400)
B C Tel Grant		(40,000)
	Residual Cost	$ 1,043,466
Logging Camp Share	17½%	$ 182,600
Community Share	82½%	860,859

Assuming financing at 12% for 25 years.

Annual Share	(Logging Camp)	23,282
Annual Share	(Community)	109,759

The community share would be split on the basis of the above assessments in (3).

Property Owner (no dwelling)	$ 253 /year
Seasonal Resident	303 /year
Permanent Resident	329 /year
Farm	404 /year
Commercial	354 /year

5. Based on estimated power usage and rate charges the costs for power (1983) would be

Category	Base Cost	Meter Cost	Power Used	Avg Cost ¢/kW.h
Property Owner	253	N/A	0	N/A
Seasonal Resident	303	369	4,000	16.5
Permanent Resident	329	594	9,000	10.3
Farm	404	843	18,000	6.9
Commercial	354	735	15,600	7.0
Logging Camp	23,282	8,100	180,000	17.4

NOTE: There is potential to use more power in the above system at a marginal cost of 4.5¢/kW.h for all categories.

As assessment values for improvements grow through new construction, the Base Costs above should be prorated to decline slightly.

3.4 COST RECOVERY

As detailed elsewhere in the report it seems most appropriate to fund the power supply system on the basis of property assessments (for base cost) and on meter readings (for power consumption). In this manner neutral parties are involved in the collection and there is assurance of recovering sufficient funds, as opposed to handling the collection through the community association. The actual funding and collection arrangements should receive thorough discussion within the community before being placed on a referendum for approval.

Other possibilities for cost recovery may exist, but potential complications may also exist. For example, if future subdivisions of land are successfully sold, or a new industry established to take advantage of the available power there would have to be a means (possibly through property assessment) by which new properties could begin to pay a fare share of the base cost and thereby leave the remaining property owners with a lighter tax burden. Such flexibilities should be built in to the power cost sharing scheme.

Stage 2

Economic and Financial Evaluation

1. INTRODUCTION

This Stage 2 Report of the Study: Evaluation of Electrical Supply Alternatives for Seymour Arm, BC is a logical follow-up to the Stage 1 Report which was completed in December 1983. The Stage 1 report addressed the following topics:

- community description;
- estimation of electrical supply requirements;
- description of three electrical supply alternatives (Grid Connection, Hydro Power Plant, Diesel Generation Station);
- cost estimates of the electrical supply alternatives;
- preliminary financing proposal.

Subsequent to the acceptance of the Stage 1 Report, which recommended a grid connection, the community through the Property Owners Association has proceeded to hold discussions with a number of interested parties including BC Hydro, BC Telephone Company, the Columbia-Shuswap Regional District, Federated CO-OP (logging camp), the Ministry of Forests and Highland Powerlines Ltd. All parties have expressed support for the proposed grid connection and efforts have been made to update the relevant costs presented in Stage 1. These costs have been used in the analysis presented in the Stage 2 Report.

Arrangements have been made for $15,000 funding through the Regional District to carry out the staking survey which will enable the construction costs to be confirmed. Following this, the eventual costs to the consumer can be predicted and these will become the basis for the costs shown on the referendum scheduled for the Victoria Day Weekend (1984). The project will then proceed if the community votes its financial support through increased tax assessments.

The Stage 2 Study analyses the economic and financial costs of all three electrification options and presents the relative merits of each from the national and local perspectives. For this work the latest available costs especially pertaining to the grid connection were used so as to provide the most accurate information for the referendum.

2. BACKGROUND

In Stage 1 of the study, the three technically feasible electricity supply alternatives were discussed. In this stage, the least cost alternative is identified from the perspective of the Canadian economy and from the perspective of the community of Seymour Arm.

The economic analysis views the cost of the three alternatives from the perspective of the Canadian economy. From this broader perspective, what may appear to be a cost to one group may be an income transfer within society.

Taxes, subsidies, and grants are of this nature and do not constitute an economic cost. Inflation, which is a general rise in the price level, is also not an economic cost. An economic cost is the social value of the output foregone from the alternative highest valued use of the economic resource. This is termed the social opportunity cost of the resource. An economic resource is any scarce commodity which has alternative uses, such as fertile land, and skilled labour. For example, the transmission right of way for the grid extension may occupy land that would otherwise be productive forest land. Although the financial rent on the land may be a nominal sum, the economic cost is the net value of the foregone future harvest of trees. In general, market prices adequately reflect the social opportunity cost of the economic resource. However there are several important exceptions with respect to the three electricity supply alternatives and these exceptions will be discussed in the next section.

The financial analysis views the three alternatives from the perspective of the Seymour Arm landowner/electricity consumer. It estimates the actual out of pocket expense the landowners should be prepared to commit in selecting a given option. In the financial analysis, grants and subsidies are explicitly included as they reduce the cost to the community.

The purpose of the two analyses are distinct. The economic analysis identifies the least cost alternative from the perspective of the Canadian economy, while the financial analysis adopts the community perspective. If it is true that all of the important considerations of the three alternatives are embedded in the cost estimates, then the least cost option identified in the economic analysis is the preferred alternative. If the financial analysis points to a different supply option, then public policy measures should be considered to reorient the financial incentives. Appropriate public policy measures might include direct grants, tax relief, or other forms of assistance. Indeed, a number of programs within the National Energy Program are aimed at modifying existing financial incentives to achieve specific social goals (e.g. secure supply of energy, Canadian ownership).

Lastly, the economic analysis completed here identifies the least cost option of the three supply alternatives under consideration. It does not assess whether any option is economically desirable. That is, whether the gains to society in proceeding with a given option exceed the cost. It is true that two of the three options will reduce oil consumption. But, from the economic perspective, a reduction in oil consumption is only preferred if the energy needs of the community can be met at a lower overall economic cost. With the fall in oil prices and the long term outlook for relatively stable prices, many of the off-oil alternatives are not as economically attractive as they once were. Economic desirability is often determined using benefit-cost analysis wherein the social gains and losses are explicitly addressed. Although such analysis was not undertaken here, the efforts of the Seymour Arm residents and their intention to pay for a relatively large share of the project suggests that substantial social benefits will acrue to the community. Also, to the extent that the electrification of Seymour Arm would reduce oil consumption, an income benefit acrues to the nation. This latter benefit will be quantified in the following analysis.

3. ECONOMIC ANALYSIS

3.1 GENERAL

The economic analysis is designed to re-evaluate the major categories of project cost. For several cost items, the financial cost did not reflect the social opportunity cost and adjustments were required. The rationale and method for making these adjustments will be discussed in detail.

For the three supply options, the following cost categories were examined:

- land
- labour, material and equipment
- diesel oil
- purchased electricity

3.2 LAND

The land required by the three alternatives includes the transmission line right of way for the grid connection, and the property for the powerhouse and ancillary works for the other two options. The economic cost of allocating the particular parcels to one of these alternatives is the value foregone in the next best use of the land. The example presented earlier of allocating productive forest land illustrates the nature of the cost. However, it appears that the alternative uses of much of this land is severely limited.

The potential transmission line corridor for the grid connection parallels in many places an existing road. Installing the line would simply widen the existing corridor. It is our understanding that such an effect would not foreclose any alternative uses. That is, the economic cost of allocating the land to this specific use is zero. Nevertheless, a cost of $100 per hectare has been assigned to the grid connection option in the event this preliminary assessment overlooked an alternative valuable use. Our information indicates that the corridor will be approximately 12 metres (40 feet) wide and 40 kilometres long, for a total land area of 48 hectares. A land cost of $4800 was therefore assigned to this alternative.

The hydro power alternative would require land for the hydro facility, the transmission line to the community, and the powerhouse for the stand-by diesel unit. The hydro power facility would require about one hectare for the plant and the penstock right of way. The transmission line corridor of six metres wide and ten kilometres long requires an additional six hectares. This land has also been assigned a nominal value of $100/hectare. The standby diesel powerhouse would be located near the community on what might otherwise be a recreational lot. The assessed value of these lots varies from $12,000 -$15,000. On the assumption that the standby diesel plant would occupy one of the lower valued sites, a cost of $12,000 has been assigned. The total land cost of the hydro power option is therefore $12,700.

The diesel generation alternative would occupy a lot near the community. A land cost of $12,000 has been assigned this option.

It should be noted that a cost has not been imputed to the land required for the distribution system. Accounting for this land would add the same amount to the total cost of each alternative. Hence excluding the land cost of the distribution system does not effect the relative cost of the three options. Since the purpose of this analysis is to identify the least cost alternative, it is the relative cost that is relevant.

3.3 LABOUR, MATERIAL AND EQUIPMENT

The economic cost of material and equipment has been taken to be the respective quoted market price. This includes the cost of clearing the land, purchasing and installing the equipment, and operating the facility over a twenty year period. The prices of these goods are determined in reasonably efficient markets. That is, in markets with enough buyers and sellers to provide sufficient competition so that the market price adequately measures the value of the good in its next best alternative use. Embedded in the equipment costs are taxes which are not an economic cost. In terms of the total cost, the tax portion was thought to be relatively minor, and no attempt was made to remove them. Except for the effects of general price inflation, the economic and financial cost of these items are identical.

There is an operating expense for the grid extension alternative that is treated as an explicit economic cost while it is less obvious in the financial assessment. This is the annual cost of maintaining the transmission right of way. This cost is estimated by BC Hydro to be in the order of $30,000 - $40,000 for the first four years and then an average annual value of $10,000 in subsequent years. An economic cost of $35,000 per year for the first four years was assigned to this activity followed by an annual cost of $10,000. In practice, this cost would be borne by all BC Hydro electricity customers through their rates.

Lastly, this analysis has neglected to include an estimate of the value of the timber harvested under each of the alternatives. This timber would be cleared from the transmission right of way. Inclusion of this item would reduce project costs since the harvest of commercially valuable timber represents a positive flow to the economy. The magnitude of this item is likely greatest for the grid extension alternative because of the larger land area cleared. To the extent this positive effect has been neglected, the cost of the respective alternative has been overstated.

3.4 DIESEL OIL

The economic cost of diesel oil is greater than the financial cost because the Canadian blended oil price is less than the corresponding open market price (e.g. the price Canadian oil would fetch on the world market). We have adjusted for this difference by estimating the cost of diesel as if domestic refiners were paying the world price for crude oil. The first step in deriving this estimate is to adopt a world price forecast.

The world price of crude oil, as measured by Saudi Arabia marker crude (FOB Persian Gulf), has fallen substantially from its high of (US)$230 per cubic metre ($m^3$) in early 1981 to a price of about $175/$m^3$ in January 1984. This weakening in the price is generally attributed to demand related factors over which OPEC has relatively little control. These include reduced consumption due to the

economic recession, switching to lower cost fuels, and conservation measures in general. The outlook for the next several years is for this moderate price decline to continue. By 1986 however, the world economy is expected to have sufficiently recovered to cause the real price of oil to rise slowly.

Since there is a large band of uncertainty involved in forecasting world oil prices, we have adopted a lower and higher forecast for the purposes of this study. The two forecasts are presented in Table 3.1. In the lower forecast, the price of crude oil falls to $\$169/m^3$ before commencing to escalate in real terms in 1986. For the higher cost scenario, the price forecast follows the same path as the lower forecast until 1986, then begins to escalate at a faster annual average rate. The price forecasts refer to Saudi marker crude, Persian Gulf. The quality of conventional old oil produced in Alberta is of generally superior quality hence would sell for a premium price. In Columns 3 and 4 the quality adjusted price of domestic oil corresponding to the respective world oil price scenario is presented. These latter values were used to estimate the economic cost of diesel oil. It might be noted that the world oil price forecast adopted in this study is generally in line with the more recent forecasts prepared by Canadian forecasting agencies.

The price of diesel oil at the refinery gate is the sum of crude oil cost and the refinery margin (operating costs plus profit). This price is often expressed as a percentage of the crude oil cost. For example, motor gasoline often sells for about 200% of the cost of crude oil, light fuel oil for about 140%[1]. Similarly diesel oil sells in the range of 135% of the cost of crude oil. A proportion of 135% of the cost of crude oil was adopted for this study.

Finally, the economic cost of transporting the fuel to the community of Seymour Arm must be added. This cost was taken to be \$0.14/litre in 1983 and remained constant in real terms over the forecast period. The transportation cost estimate was computed as the difference between the present refinery plant gate price of about \$0.308/litre and the cost of diesel reported in the community fo \$0.45/litre. The forecast price of diesel fuel at Seymour Arm is presented in Columns and 5 and 6.

3.5 ELECTRICITY

The economic cost of electricity is defined as the greater of either the cost of providing the energy of the maximum price an additional customer is willing to pay. In most instances the economic cost will diverge from the rates paid by electricity consumers on the BC Hydro system since the latter are set to meet the financial requirements of the crown corporation. In the financial analysis, which is presented in the next section, a forecast of future electricity rates is presented. Here, the rationale adopted in determining the economic value of electricity is summarized.

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1 These ratios are based on a volumetric comparison rather than an energy equivalent basis.

TABLE 3.1

CRUDE OIL AND DIESEL OIL PRICE FORECASTS
(In constant 1983 $)

	World Price (FOB Persian Gulf)		Canadian Equivalent		Diesel Oil (Seymour Arm)	
	1 Low	2 High	3 Low	4 High	5 Low	6 High
	(US $/m^3)		(Cdn $/m^3)		($/litre)	
1983	187	187	249	294	0.48	0.48
1984	169	169	239	239	0.46	0.46
1985	169	169	239	239	0.46	0.46
1986	173	175	243	246	0.47	0.47
1987	176	180	248	252	0.47	0.48
1988	179	186	252	260	0.47	0.49
1989	183	191	257	267	0.48	0.50
1990	187	197	261	274	0.49	0.51
1995	197	227	273	311	0.51	0.56
2000	207	260	286	354	0.53	0.62
2005	227	283	311	385	0.56	0.66

(SOURCE: Robinson Consulting and Associates Ltd).

Presently, with the completion of the Revelstoke Canyon Dam, BC Hydro has surplus generating capacity. That is, an incremental increase in electricity consumption will not require an addition to the system capacity. This situation is expected to persist for some time, although one cannot be precise as to when further additions will be required. In a recent decision on the proposed Site C generation project, the BC Utilities Commission did not foresee a need before the early 1990's.

During this period of surplus capacity, the alternative use of the power has been taken to be an export sale. BC Hydro recently contracted for a three year period to the Bonneville Power Authority the sale of electricity for an average price of about 21 mills/kW.h (US$). Other export sales may be made, and the contracted price will depend on the terms and conditions of the sale agreement. For the purposes of this analysis, an average export price of 35 mills kW.h (Cdn) over the surplus period has been adopted. The surplus period has been assumed to last through 1995.

Following the surplus period, growth in electricity consumption would require additions to the generating system. Such addition might be the construction of the Site C project, or alternative smaller projects. The average delivered cost of power from the next system addition constitutes the economic cost of electricity in this latter period. Clearly, the magnitude of the cost is related to the project undertaken, which cannot be anticipated at this time. However the average delivered cost of the next increment of capacity will likely fall within the range of 40 - 60 mills/kW.h (1983 dollars discounted at 10%). Here, a value of 50 mills/kW.h to approximate the economic cost of electricity in the post 1995 period is used.

The economic cost of power delivered on the BC Hydro system has been assigned a value of 35 mills/kW.h to the year 1995, then 50 mills thereafter. This cost is relevant to the grid connection alternative only, since the other two options do not rely on the BC Hydro system.

3.6 RESULTS

The results of the economic analysis are summarized in Table 3.2 and Appendix 2. All economic costs are expressed in constant 1983 dollars. That is, the impact of general price inflation is excluded from the analysis because it impacts on all prices to the same extent. Only those price changes that are net of inflation are recorded (termed real price changes). Real price changes are incorporated into the forecast of diesel oil and electricity. All of the cost streams have been discounted to a present value equivalent at a 10% real rate of discount. Discounting is a standard technique for expressing different time streams of expenditures on a comparable basis. The 10% discount rate is recommended by the federal Treasury Board and provincial benefit-cost guidelines. For sensitivity, present value costs are also expressed at the 8% and 12% discount rates.

TABLE 3.2

ECONOMIC COST COMPARISON OF THE THREE ALTERNATIVES
(In thousands of 1983 dollars)

	8%	10%	12%
Grid Connection	1,832.0	1,693.3	1,582.0
Hydro Power			
Low oil price forecast	2,941.0	2,789.6	2,663.2
High oil price forecast	2,954.0	2,799.7	2,671.0
Diesel Generation			
Low oil price forecast	2,840.4	2,411.4	2,078.0
High oil price forecast	3,039.7	2,565.0	2,198.0

(SOURCE: Robinson Consulting and Associates Ltd.)

Of the three alternatives under consideration, the grid connection is unambiguously the least cost option from the perspective of the Canadian economy. At the 10% discount rate, it is about 30% less costly than the next least cost alternative. The cost advantage is sustained over the range of discount rates and alternative oil price forecasts considered.

At the 10% discount rate, the next least cost alternative is diesel generation. The conclusion remains valid for the high and low oil price forecasts. However, at the 8% rate of discount the hydro power alternative becomes less costly given the high oil price forecast. At lower discount rates, the hydro power alternative would be preferred to the diesel generation alternative. This is because at lower discount rates the cost savings in future periods offered by hydro power relative to diesel generation becomes more significant. Aside from this purely technical relationship, the economic cost estimates for these latter two alternatives are fairly close. Given the relatively preliminary nature of the cost estimates prepared, and uncertainty related to future oil prices, it is concluded that the economic cost of the latter two alternatives are essentially the same.

The present value cost estimates presented in Table 3.2 are composed of the cost of land, materials, labour and energy. The cost of the hydro power and diesel generation options include the social cost of diesel oil which would be entirely displaced if the grid extension option was selected. Given the hydro power option, diesel generation would be used on an as required basis. Hence the social value of the displaced diesel is relatively small. At a ten percent discount rate, a present value equivalent of $125,000 of diesel fuel would be saved if the grid extension was selected. At the higher oil price forecast, the value of the displaced fuel increases to $135,000. The diesel generation option would require relatively large volume of diesel over the system's operating life. In economic terms, the present value cost of diesel that could be displaced by the grid extension is about $1.9 M given the low oil price forecast and about $2.05 M given the higher forecast. Hence if one were to compare the three options according to the major cost components, the following general conclusions would be found:

- the grid extension is less costly than the hydro power option primarily due to relatively lower capital costs;
- the cost of diesel fuel is a relatively minor cost item for the hydro power option;
- with respect to the diesel generation alternative, the grid extension is a relatively higher capital cost;
- the lower total cost of the grid extension can be attributed to displacement of diesel fuel.

4. FINANCIAL EVALUATION

4.1 GENERAL

The financial evaluation attempts to estimate the actual out of pocket costs of the three alternatives to the Seymour Arm landholder. The analysis differs from the economic analysis in that specific grants and subsidies available to the community are relevant in reducing the financial cost. Inflation is also included in the analysis since it effects the cash flow in the community. The analysis has been conducted on a pre-tax basis since the tax aspects of the three alternatives do not appear to be significant.

Two other major differences between the financial and economic analysis are the treatment of diesel oil and electricity rates. These differences are addressed below before the results of the financial analysis are considered.

4.2 DIESEL OIL

The domestic price of crude oil is a weighted average price of domestic oil (conventional old oil) which earns less than the world price, domestic production earning the world price, and imported oil. This is termed the blended price. The blended price will slowly rise to world levels as the proportion of old oil declines relative to total domestic supply.

Estimates have been made of the blended oil price using the world oil price forecasts presented earlier, and specific policy assumptions consistent with the pricing agreements between the Government of Canada and the Government of Alberta. Specifically, the price of conventional old oil will escalate with a rising world oil price but will not exceed 75% of the world price on a quality adjusted basis. (This 75% cap is consistent with the present energy agreements.) The blended oil price has been converted into a diesel oil price forecast assuming a 135% mark up factor discussed earlier. A transportation cost of $0.14/litre (1983 dollars) was added to this total to derive the diesel oil price forecast for Seymour Arm. The blended crude and diesel oil price forecasts are presented in Table 4.1.

A comparison of Tables 3.1 and 4.1 may convey the impression that the blended oil price forecast exceeds the world price. This is solely due to the effects of inflation. The price forecasts presented in Table 3.1 are expressed in constant 1983 dollars. If the prices of Table 3 were also expressed in constant 1983 dollars then the blended price forecast would be less in all years. The assumptions in this study regarding future inflation rates are contained in Appendix 3.

TABLE 4.1

CRUDE OIL BLENDED PRICE AND DIESEL OIL DOMESTIC PRICE FORECAST
(Nominal, Canadian dollars)

	Blended Oil Price ($/m^3)		Diesel Oil Price ($/litre)	
	Low	High	Low	High
1983	229	229	.45	.45
1984	227	227	.45	.45
1985	237	240	.47	.48
1986	251	253	.50	.50
1987	270	275	.53	.54
1988	287	295	.56	.57
1989	304	316	.57	.58
1990	323	339	.62	.64
1995	426	483	.80	.88
2000	535	671	1.00	1.18
2005	679	924	1.25	1.58

(SOURCE: Robinson Consulting and Associates, Ltd)

4.3 ELECTRICITY RATES

All provincial electricity consumers on the BC Hydro grid system pay a fixed rate schedule depending on customer categories regardless of the real cost involved in serving them. This schedule consists of a demand charge and a declining block commodity charge. In March 1984, the fixed demand charge on a two month billing basis for a residential customer is $5.90. The commodity charge is 5.8164 cents for the first 550 kW.h and 4.0436 for the remaining consumption during the billing period. We have assumed that given the opportunity, the permanent residents of Seymour Arm will consume the provincial average per year, or 9000 kW.h. This translates into an average rate of 5.087 cents/kW.h. The seasonal resident is assumed to require 4000 kW.h per year which results in an average cost per kilowatt hour of 6.391 cents. If this were the case then the weighted average cost per kW.h (assuming a 25/75 percent split between permanent and seasonal residents) is 6.065 cents/kW.h.

Electricity rates are anticipated to escalate at a relatively high rate in future years. This is due to the utility's large debt service requirement, higher provincial water fees, and the instruction to move toward a specific interest coverage ratio. The utility is anticipated to request a 6.5% rate increase in 1984 and probably seek annual rate increases of 8% thereafter. The electricity rate forecast developed here assumes a 6.5% escalation in 1984 from a base value of 6.065 cents/kW.h and an 8% increase thereafter.

The electricity rate forecast applies to the financial analysis of the grid extension only. The annual electricity price forecast can be found in Appendix 3, Table 1.

4.4 RESULTS

The results of the financial analysis are presented in Table 4.2 and Appendix 3. A different discount rate has been used in bringing the financial cost streams to a present value equivalent. In the financial analysis the discount rate corresponds to the return the community landholders would receive in their next best investment. The relatively low inflation rate assumed in this analysis implies a relatively low interest rate. Over the long term it was assumed that the landholders could earn a nominal return on a similar investment in the order of 8% to 10%.

For the grid extension, the latest cost estimates made available by the Seymour Arm Property Owners Association were incorporated. It was assumed for this analysis that only new equipment and materials would be used, hence no credit was given if less expensive, used equipment was found suitable. The cost to Seymour Arm residents is determined after removing financial grants and other assistance. This includes the Rural Electrification Assistance from BC Hydro ($333,340), the contribution by BC Telephone Company ($40,000), and the portion paid by the Federated Coop ($93,947). The Property Owner's Association estimated the BC Tel contribution at $175,000, which reflects assistance for both the transmission and distribution system. However, at the time this report was being prepared BC Tel had not reached a decision whether serving the community by cable or microwave would be preferable. In any case, BC Tel indicated they would cost share the distribution system for an estimated contribution of $40,000. This latter situation has been taken to be the base case, but the results given the $175,000 contribution have been used as a sensitivity test. Although the magnitude of the contribution by BC Tel has a significant impact on the total cost of this alternative, the grid extension option remains the least cost option from the perspective of the community. Hence the preferable alternative from the broader economic perspective is also the more attractive opportunity from the more narrow community perspective.

The economic analysis found the cost of the hydro power and the diesel generation alternatives to be essentially equal. This is not the case in the financial analysis, where the hydro power option is found to be less costly. As one might expect, the relative cost advantage of the hydro power alternative increases with the higher oil price forecast.

For the hydro power alternative, a potential grant under the Remote Community Demonstration Program has been neglected. This grant is awarded on a competitive basis and is not as certain as the grants from BC Hydro and BC Tel associated with the grid extension alternative. We can however compute the minimum financial grant required by the hydro power option to make it as attractive as the grid extension from the community perspective. Assuming an 8% opportunity cost of funds, the hydro power capital grant would have to be about $850,000, or about 40% of the estimated capital cost of the facility.

TABLE 4.2

FINANCIAL COST COMPARISONS OF THE THREE ALTERNATIVES
(In thousands of nominal dollars)

	8%	10%
Grid Connection		
(BC Tel Contribution $40,000)	2,862.6	2,333.5
(BC Tel Contribution $175,000)	2,710.7	2,202.4
Hydro Power		
Low oil price forecast	3,867.7	3,302.2
High oil price forecast	3,892.1	3,320.5
Diesel Generation		
Low oil price forecast	4,180.2	3,409.3
High oil price forecast	4,551.2	3,687.0

(SOURCE: Robinson Consulting and Associates, Ltd)

5. SELECTED FINANCING SCHEME FOR SEYMOUR ARM

5.1 GENERAL

Following the proposals of the Stage 1 Study, discussions have been held between the community and the Regional District of Columbia-Shuswap to implement a financial package to cover the funding shortfall left after the applicable grants are deducted from the estimated capital cost. These discussions have resulted in the referendum scheduled for the Victoria Day Weekend (1984) and the proposed tax assessment on all properties in the region. In this section the background to the various cost estimates is presented.

5.2 PROPERTY TAX ASSESSMENTS

The key to the financing proposal is that the funding shortfall in the project would be made up of contributions from all property owners in the service area based on a fixed mill rate and the actual assessed property value. The range of typical values is shown in Table 5.1.

TABLE 5.1

Actual Assessed Value of all Properties	8,381,902
Loan Repayment based on 12% Interest 25 year amortization (Capital Recovery Factor = .1275)	
Typical Assessed Values:	
Vacant Lot	14,400
Summer Cabin	28,450
Permanent Residence	80,625

Note: There is a wide range of value in permanent residences.

5.3 COSTS OF POWER PER PROPERTY OWNER

The costs of grid power to the individual property owner are determined on the basis of the property tax assessment ratios, the net project cost and the user charge based on the meter readings. The net project cost of $681,737 is detailed in Appendix 1. This cost presented is the most pessimistic in terms of the costs to the property owners of Seymour Arm. The resulting cost to various consumer categories is shown in Table 5.2.

In the more optimistic view, the total cost estimated may be reduced as shown below:

- potential savings with the use of approved equipment on transmission line $135,000

- potential savings of not paying for an upgrading of the power line to St Ives, in recognition that a single phase line is adequate for the present needs of the community, but a 3 phase line is being proposed at additional cost;

  $175,000

- potential savings if BC Telephone Company decides to provide service along the pole line as opposed to microwave (40% share of pole in place cost);

  $ 75,000

- potential savings (extra costs) when bids are received for the construction of the work.

  $ to be confirmed

The effect of the first three reductions is shown in Table 5.2. The eventual cost to the property owners will likely lie between these two ranges. Other factors which have not been included at this time because they are somewhat speculative include:

- additional permanent or seasonal residents in the community who connect to the system by the time the power line is energised would generate further REA grants of $11,000 and $400 respectively thus lowering the community's contribution;

- each year's growth in the community through new construction will increase the tax base and thus lower the average individual contribution.

TABLE 5.2

Cost of Grid Connection (based on Costs of January 1984)	$ 1,295,970
Required Community Contribution	681,737
Annual Contribution based on 12% Financing 25 year amortization	86,921
Property Tax base	8,381,902
Mill Rate = $\frac{\text{contribution}}{\text{Assessment Base}}$	$10.47/$1000
Permanent Resident	
Property Tax based on $80,625 assessment	$ 844.14
Bi-Monthly Connection Charge	36.00
Meter Charges (Average 4.687¢ x 9000 kW.h)	421.83
Total Cost of Power	$ 1,301.97
Average Cost of Power	14.46¢/kW.h

Seasonal Resident

Property Tax based on $28,450 Assessment	$ 297.87
Bi-Monthly Connection Charge	36.00
Meter Charges (Average 5.54 x 4000 kW.h)	220.00
Total Cost of Power	$ 553.87
Average Cost of Power	13.85¢/kW.h

Vacant Lot

Property Tax only based on $14,400 Assessment	$ 150.75

TABLE 5.3

Cost of Grid Connection (based on Costs of January 1984 and maximum foreseeable deductions)	$ 1,295,970
Required Community Contribution	362,187
Annual Contribution based on 12% Financing 25 year amortization	46,179
Property Tax base	8,381,902
Mill Rate = $\frac{\text{contribution}}{\text{Assessment Base}}$	$5.51/$1000

Permanent Resident

Property Tax based on $80,625 Assessment	$ 444.19
Monthly Connection Charge	36.00
Meter Charges	421.83
Total Cost of Power	$ 902.02
Average Cost of Power	10.0¢/kW.h

Seasonal Resident

Property Tax based on $28,450 Assessment	$ 156.76
Monthly Connection Charge	36.00
Meter Charges	220.00
Total Cost of Power	$ 412.74
Average Cost of Power	10.32¢/kW.h

Vacant Lot

Property Tax only based on $14,400 Assessment	$ 79.34

6. FINDINGS AND RECOMMENDATIONS

The focus of the economic and financial analysis was to determine the least cost electricity supply option of three proposed for providing electricity to the community of Seymour Arm. The results clearly indicate that the grid extension is the least cost alternative relative to the hydro power and diesel generation options. The findings are relatively conclusive to the degree that the cost differential between the grid extension and the next least cost option is large. That is, the grid extension will remain the preferred option over a wide range of parameter values and alternative forecasts of prices. Perhaps the greatest uncertainty in forecasting future prices is in the forecast of both world and domestic oil prices. The outlook adopted here was one of relatively modest real growth. To the extent world and domestic oil prices exceed those forecast here, the cost advantage of the grid connection alternative will increase.

The analysis did not address questions of economic desirability or the financial capacity of the community to undertake the project. These questions can best be answered by the landowners who will receive a large share of the project benefits as well as bear a large proportion of the financial costs. Only they can put a value on the power they would use and the cost of its alternative supply source. To this end the referendum to be held in May 1984 will be the final test of the proposed systems economic desirability.

In the meantime the Property Owner's Association is continuing to improve the estimate of the community's cost. This can only be done by refining the construction cost through a more accurate definition of the project (the $15,000 design survey) and by reaching contribution agreements with the various agencies proposing to assist with the project.

If the preceding stages go well and the referendum passes, then the project will go ahead. Much work will still need to be done including:

- tender document finalization prior to calling for tenders;
- tender analysis and contract document preparation;
- assembly of a project management team to administer the contract, coordinate inspections and deal with agencies;
- assembly of approvals for Crown Land rights of way and other easements;
- securing financing through the Regional District;
- finalization of the number of connections to determine REA grants.

APPENDIX 1

Revised cost estimates for grid connection

COST ESTIMATE

SEYMOUR ARM GRID CONNECTION

(Based on Highland Powerlines Ltd letter of December 15, 1983 and BC Hydro letter of September 14, 1983)

Design and Survey Cost (to BC Hydro)	$ 15,000
Clearing	120,000
25 Miles (40 km) of Transmission Line	
Materials	383,400
Labour/Equipment	286,250
5 Miles (8 km) Single Phase Distribution	
Materials	43,290
Labour/Equipment	52,530
100 Transformers and Service Drops	
Materials	95,700
Labour/Equipment	24,800
Upgrading to St Ives (BC Hydro Estimate)	175,000
Total Cost	**$ 1,195,970**
Contingency	100,000
	$ 1,295,970

Summary of Deductions and Subsidies On the Total Cost

REA Grants	
Permanent 26 @ $11,000	$ 286,000
Seasonal 2/3 x 110 @ $400	29,600
Commercial 5 @ $11,000	55,000
Farms 2 @ $15,800	31,600
Logging Camp (4 x Est Annual Revenue)	32,400
BC Telephone Grant (Distribution Line only)	40,000
Total	**$ 474,600**
Residual Cost	821,370
Less Federated Co-Op Contribution (17% of Residual)	139,633
Net Chargeable to Residents (Worst Case)	$ 681,737

Additional Possible Deductions:	
BC Tel Pole Share on Transmission Line	$ 75,000
Deduction for St Ives upgrading (charged to BC Hydro)	175,000
Used equipment allowance (maximum)	135,000
	$ 385,000
Residual Cost	436,370
Federated Co-Op Contribution	74,183
Net Chargeable to residents (Best Case)	$ 362,187

TABLE A2-1
ECONOMIC ANALYSIS OF GRID CONNECTION ALTERNATIVE

YEAR	land	clearing	survey	system upGrade St. Ives	3 Phase line	dist. system	total non-elec O&M	annual costs	demand in kWh	op. cost mills note ₵	elect. cost per year	ANNUAL TOTAL COST
0	4775	120000	15000	175000	669650	216320	0	1200745	0	0.035	0	1200745
1	0	0	0	0	0	0	35000	35000	1012500	0.035	35437.5	70437.5
2	0	0	0	0	0	0	35000	35000	1080337	0.035	37811.8	72811.8
3	0	0	0	0	0	0	35000	35000	1152720	0.035	40345.2	75345.2
4	0	0	0	0	0	0	35000	35000	1229952	0.035	43048.3	78048.3
5	0	0	0	0	0	0	10000	10000	1312359	0.035	45932.6	55932.6
6	0	0	0	0	0	0	10000	10000	1375352	0.035	48137.3	58137.3
7	0	0	0	0	0	0	10000	10000	1441369	0.035	50447.9	60447.9
8	0	0	0	0	0	0	10000	10000	1510555	0.035	52869.4	62869.4
9	0	0	0	0	0	0	10000	10000	1583061	0.035	55407.1	65407.1
10	0	0	0	0	0	0	10000	10000	1659048	0.035	58066.7	68066.7
11	0	0	0	0	0	0	10000	10000	1715456	0.035	60041.0	70041.0
12	0	0	0	0	0	0	10000	10000	1773781	0.05	88689.1	98689.1
13	0	0	0	0	0	0	10000	10000	1834090	0.05	91704.5	101705.
14	0	0	0	0	0	0	10000	10000	1896449	0.05	94822.5	104822.
15	0	0	0	0	0	0	10000	10000	1960928	0.05	98046.4	108046.
16	0	0	0	0	0	0	10000	10000	2027608	0.05	101380	111380
17	0	0	0	0	0	0	10000	10000	2096538	0.05	104827.	114827.
18	0	0	0	0	0	0	10000	10000	2167821	0.05	108391.	118391.
19	0	0	0	0	0	0	10000	10000	2241526	0.05	112076.	122076.
20	0	0	0	0	0	0	10000	10000	2317738	0.05	115887.	125887.

8%= 1.366E7
10%= 1.135E7
12%= 9562126

Present value:		average cost kWh
8%	1832037	0.13489
10%	1693267	0.14913
12%	1581978	0.16544

NOTES

. . .

₵. assumed an export value of 35mills to 1995, then an incremental cost of 50 mills

TABLE A2-2

ECONOMIC ANALYSIS OF SMALL HYDRO ALTERNATIVE

year	land	small hydro unit	annual cost	diesel back up	diesel annual cost	total non-fuel costs	annual electric in kWh	annual fuel in liter note 1	low cost $/liter	high cst $/liter note 2	fuel bil low Prc note 2	fuel bil high Prc note 2	TOTAL COST low oil	TOTAL COST high oil
0	12700	2017700	0	366320	0	2396720	0	0	0.46	0.46	0	0	2396720	2396720
1	0	0	40354	0	22500	62854	1012500	337500	0.46	0.46	10215.5	10215.5	73069.5	73069.5
2	0	0	40354	0	22500	62854	1080337	360112.	0.47	0.47	11136.8	11136.8	73990.8	73990.8
3	0	0	40354	0	22500	62854	1152720	384240	0.47	0.48	11883.0	12135.8	74737.0	74989.8
4	0	0	40354	0	22500	62854	1229952	409984	0.47	0.49	12679.2	13218.7	75533.2	76072.7
5	0	0	40354	0	22500	62854	1312359	437453	0.48	0.5	13816.5	14392.2	76670.5	77246.2
6	0	0	40354	0	22500	62854	1375352	458451.	0.49	0.51	14781.4	15384.7	77635.4	78238.7
7	0	0	40354	0	22500	62854	1441369	480456.	0.49	0.52	15490.9	16439.3	78344.9	79293.3
8	0	0	40354	0	22500	62854	1516555	505518.	0.5	0.53	16565.8	17559.7	79419.8	80413.7
9	0	0	40354	0	22500	62854	1583061	527687	0.5	0.54	17360.9	18749.8	80214.9	81603.8
10	0	0	40354	0	22500	62854	1659048	553016	0.51	0.55	18558.1	20013.6	81412.1	82867.6
11	0	0	40354	0	22500	62854	1715456	571819.	0.51	0.56	19189.1	21070.4	82043.1	83924.4
12	0	0	40354	0	22500	62854	1773781	591260.	0.51	0.57	19841.5	22175.8	82695.5	85029.8
13	0	0	40354	0	22500	62854	1834090	611363.	0.52	0.59	20918.4	23734.3	83772.4	86588.3
14	0	0	40354	0	22500	62854	1896449	632150.	0.52	0.6	21629.6	24957.3	84483.6	87811.3
15	0	0	40354	0	22500	62854	1960928	653643.	0.53	0.61	22795.1	26235.9	85649.1	89089.9
16	0	0	40354	0	22500	62854	2027600	675867.	0.53	0.62	23570.2	27572.7	86424.2	90426.7
17	0	0	40354	0	22500	62854	2096538	698846	0.54	0.62	24831.4	28510.1	87685.4	91364.1
18	0	0	40354	0	22500	62854	2167821	722607	0.54	0.63	25675.7	29955.0	88529.7	92809.0
19	0	0	40354	0	22500	62854	2241526	747175.	0.55	0.64	27040.3	31465.0	89894.3	94319.0
20	0	0	40354	0	22500	62854	2317738	772579.	0.55	0.65	27959.6	33043.2	90813.6	95897.2

NOTES:

1. 1 liter=3kWh
2. standby diesel to supply .0650of totalelect consumption from 10000/152000 the ratio ofdiesel fuel cost in standby vesus full diesel opting

Present value:	low	high
8%	2940934	2954049
10%	2789568	2799681
12%	2663226	2671116

TABLE A2-3
ECONOMIC ANLAYSIS OF DIESEL GENERATION ALTERNATIVE

year	diesel station	land	trans. line	distr. line	diesel gen	line O&M	totallow pric non-fuelfuel bil costs	high price fuel bil		TOTAL COST low oil	high oil
0	150000	12000	35000	216320	0	0	413320	0	0	413320	413320
1	0	0	0	0	15000	4000	19000	155250	155250	174250	174250
2	0	0	0	0	15000	4000	19000	169253.	169253.	188253.	188253.
3	0	0	0	0	15000	4000	19000	180593.	184435.	199593.	203435.
4	0	0	0	0	15000	4000	19000	192692.	200692.	211692.	219692.
5	0	0	0	0	15000	4000	19000	209977.	218727.	228977.	237727.
6	0	0	0	0	15000	4000	19000	224641.	233810.	243641.	252810.
7	0	0	0	0	15000	4000	19000	235424.	249837.	254424.	268837.
8	0	0	0	0	15000	4000	19000	251759.	266865.	270759.	285865.
9	0	0	0	0	15000	4000	19000	263844.	284951.	282844.	303951.
10	0	0	0	0	15000	4000	19000	282038.	304159.	301038.	323159.
11	0	0	0	0	15000	4000	19000	291628.	320218.	310628.	339218.
12	0	0	0	0	15000	4000	19000	301543.	337018.	320543.	356018.
13	0	0	0	0	15000	4000	19000	317989.	360784.	336989.	379784.
14	0	0	0	0	15000	4000	19000	328718.	379290.	347718.	398290.
15	0	0	0	0	15000	4000	19000	346431.	398722.	365431.	417722.
16	0	0	0	0	15000	4000	19000	358289.	419037.	377289.	438037.
17	0	0	0	0	15000	4000	19000	377377.	433285.	396377.	452285.
18	0	0	0	0	15000	4000	19000	390288.	455242.	409288.	474242.
19	0	0	0	0	15000	4000	19000	410946.	478192.	429946.	497192.
20	0	0	0	0	15000	4000	19000	424919.	502177.	443919.	521177.

Present value:

	low	high
8%	2840392	3839718
10%	2411356	2565038
12%	2078049	2197945

APPENDIX 3 - Financial cost analysis

TABLE A3-1

ELECTRICITY RATE FORECAST

riod	CPI 1983=100	
1984	1.04523	0.06459
1	1.08689	0.06976
2	1.13034	0.07534
3	1.17557	0.08137
4	1.223	0.08788
5	1.2724	0.09491
6	1.32372	0.10250
7	1.3764	0.11070
8	1.4312	0.11956
9	1.4882	0.12912
10	1.5474	0.13945
11	1.60897	0.15061
12	1.6733	0.16266
13	1.7403	0.17567
14	1.8099	0.18972
15	1.8823	0.20490
16	1.95762	0.22129
17	2.0359	0.23900
18	2.1174	0.25812
19	2.2021	0.27877
20	2.2902	0.30107

TABLE A3-2

FINANCIAL ANALYSIS OF GRID CONNECTION ALTERNATIVE

annual community cash requirements

Period	loan	elect. demand	elect. bill	annual cost
1994	86413.6	0	0	86413.6
1	86413.6	1012500	70533.1	157047.
2	86413.6	1080337	81394.7	167808.
3	86413.6	1152720	93796.1	180210.
4	86413.6	1229952	108087.	194500.
5	86413.6	1312359	124555.	210969.
6	86413.6	1399352	140976.	227390.
7	86413.6	1441369	159563.	245976.
8	86413.6	1510555	180599.	267013.
9	86413.6	1583061	204489.	290823.
10	86413.6	1659048	231359.	317772.
11	86413.6	1715456	258363.	344777.
12	86413.6	1773781	288519.	374933.
13	86413.6	1834090	322195.	408609.
14	86413.6	1896449	359802.	446215.
15	86413.6	1960928	401798.	488211.
16	86413.6	2027600	448696.	535109.
17	86413.6	2096538	501067.	587481.
18	86413.6	2167821	559552.	645966.
19	86413.6	2241526	624863.	711276.
20	86413.6	2317738	697797.	784210.

capital cost summary:

survey	15000
clearing	120000
trans.	669650
dist.	216320
upGrade	175000
total	1195970

less contributions of:

REA	333340
BC Tel	40000
FedCoop	93947
total	467287

(estimates from Jan. 25,'84 letter from the Seymour Arm Property Owners Ass. to Sigma except for the BC Tel contribution.)

owner's share: 728683

annual cost: 86413.6per year assuming a 728000 debt over 25 years at 1:

present value:

8%	2862558
18%	2333525

TABLE A3-3
FINANCIAL ANALYSIS OF SMALL HYDRO ALTERNATIVE

annual cash requirements

Period	loan	hydro O&M	diesel O&M	non-energy costs	diesel use lt/yr	diesel price $/lt	diesel price $/lt	annual cost low	annual cost high
1984	283000	0	0	283000	0	0.45	0.45	283000	283000
1	283000	42179.1	23517.6	348697.	22207.5	0.47	0.48	359134.	359356.
2	283000	43860.5	24455.1	351316.	23695.4	0.5	0.5	363163.	363163.
3	283000	45613.8	25432.7	354047.	25283.0	0.53	0.54	367446.	367699.
4	283000	47438.9	26450.3	356889.	26976.9	0.56	0.57	371996.	372266.
5	283000	49352.9	27517.5	359870.	28784.4	0.57	0.58	376278.	376565.
6	283000	51346.4	28629	362975.	30166.1	0.62	0.64	381678.	382282.
7	283000	53417.3	29783.7	366201.	31614.0	0.66	0.68	387866.	387699.
8	283000	55543.2	30969	369512.	33131.5	0.7	0.73	392704.	393698.
9	283000	57754.6	32202	372957.	34721.8	0.74	0.78	398651.	400040.
10	283000	60054.8	33484.5	376539.	36388.5	0.78	0.83	404922.	406742.
11	283000	62443.8	34816.5	380260.	37625.7	0.8	0.88	410361.	413371.
12	283000	64928.6	36201.9	384130.	38904.9	0.84	0.94	416811.	420701.
13	283000	67524.3	37649.3	388174.	40227.7	0.88	1	423574.	428401.
14	283000	70228.1	39156.8	392385.	41595.4	0.92	1.06	430653.	436476.
15	283000	73036.7	40722.8	396759.	43009.7	0.96	1.12	438049.	444930.
16	283000	75958.3	42351.8	401310.	44472.8	1	1.18	445782.	453787.
17	283000	78997.8	44046.5	406044.	45984.1	1.05	1.25	454328.	463524.
18	283000	82156.7	45807.8	410964.	47547.5	1.09	1.33	462791.	474283.
19	283000	85445.6	47641.5	416087.	49164.1	1.14	1.41	472134.	485408.
20	283000	88863.5	49547.3	421411.	50835.7	1.19	1.49	481985.	497156.

present value:	low	high
8%	3867689	3892145
10%	3302210	3320482

capital cost summary:

hydro 2017700

diesel 366320

total 2384020

annual charge for 25 yrs at 11% 283000

TABLE A3-4

FINANCIAL ANALYSIS OF DIESEL GENERATION

annual cash requirements

Period	loan	diesel O&M	line O&M	non-fuel costs	low fuel bill	high fuel bill	total costs low	total costs high
1984	47650	0	0	47650	0	0	47650	47650
1	47650	16383.4	4347.58	68301.8	158625	162000	226926.	230301.
2	47650	16955.1	4521.37	69126.5	180056.	180056.	249183.	249183.
3	47650	17633.5	4782.28	69985.8	203647.	207490.	273633.	277475.
4	47650	18345	4892	70887	229591.	233691.	300478.	304578.
5	47650	19086	5089.6	71825.6	249348.	253723.	321174.	325548.
6	47650	19855.8	5294.87	72800.6	284239.	293408.	357040.	366209.
7	47650	20646	5505.6	73801.6	317181.	326718.	390903.	400512.
8	47650	21468	5724.8	74842.8	352463.	367568.	427306.	442411.
9	47650	22323	5952.8	75925.8	390488.	411596.	466414.	487522.
10	47650	23211	6189.6	77050.6	431352.	459083.	508403.	536854.
11	47650	24134.6	6435.90	78220.5	457455.	503200.	535675.	581421.
12	47650	25099.5	6693.2	79442.7	496639.	555785.	576101.	635227.
13	47650	26104.5	6961.2	80715.7	538000.	611363.	618715.	692079.
14	47650	27148.5	7239.6	82038.1	581578.	670079.	663616.	752117.
15	47650	28234.5	7529.2	83413.7	627497.	732080.	710911.	815493.
16	47650	29364.3	7830.48	84844.8	675867.	797523.	760711.	882367.
17	47650	30538.5	8143.6	86332.1	733788.	873558.	820120.	959090.
18	47650	31761	8469.6	87880.6	787642.	961067.	875522.	1048948
19	47650	33031.5	8808.4	89489.9	851780.	1053517	941270.	1143007
20	47650	34353	9160.8	91163.8	919369.	1151143	1010533	1242307

capital cost summary

diesel station: 185000

trns+dst system: 216320

total: 401320

annual cost at 11% over 25 years 47650

present value:	low	high
8%	4180179	4551855
10%	3409345	3687836